NATIONAL MUSEUM OF VICTORIA

Contents.

JANUARY, 1935.

		PAGE
"Bleached" Wheat ..	*W. R. Jewell, M.Sc., F.I.C., and W. B. Miller, M.Agr.Sc.*	1
Book Review—The Veterinary Journal		4
Fumigation of Citrus Trees—Part II.	*J. L. Provan, B.Agr.Sc.*	5
Prevention of Frost Damage—Heating in Orchards	*E. E. Pescott, F.L.S., and D. D. Brown*	17
Dried Blood and Meat Meal		22
Insect Control—The Part of Insecticides	*R. T. M. Pescott, M.Agr.Sc.*	23
Asparagus Culture	*E. E. Pescott, F.L.S.*	37
Orchard and Garden Notes	*E. E. Pescott, F.L.S.*	42
Artificial Fertilizers Registered for 1935	*Will C. Robertson*	43

Issued under the direction of the Hon. J. Allan, M.L.A., Minister of Agriculture.

COPYRIGHT PROVISIONS AND SUBSCRIPTION RATES.

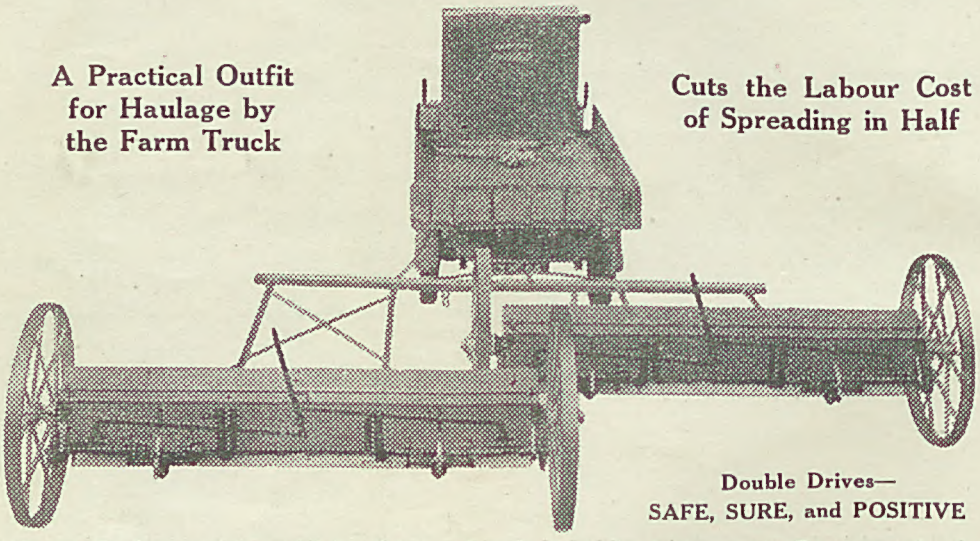
The Articles in the Journal of the Department of Agriculture of Victoria are protected by the provisions of the Copyright Act. Proprietors of newspapers wishing to republish any matter are at liberty to do so, *provided the Journal and author are both acknowledged.*

The Journal is issued monthly. The subscription, which is payable in advance and includes postage, is 3s. per annum for the Commonwealth and New Zealand, and 5s. for the United Kingdom and Foreign Countries. Single copy, Threepence. Subscriptions should be forwarded to the Director of Agriculture, Melbourne, C.2.

The "Federal" Lime and Fertiliser Spreader

A Practical Outfit for Haulage by the Farm Truck

Cuts the Labour Cost of Spreading in Half



Double Drives—
SAFE, SURE, and POSITIVE

T. Robinson & Co. have now arranged their well-known Spreaders for tandem haulage at a small extra cost, thus enabling twice the former area to be covered by one man in the same time. The machine can be disconnected in a few minutes for passing through gateways. *Write for particulars and prices, or see Local Agent.*

T. ROBINSON & Co. Pty. Ltd.

Head Office and Works: SPOTSWOOD, W.14, Victoria.
Showrooms: 536-538 BOURKE ST., MELBOURNE, Victoria.
Sydney Office & Depot: RAILWAY PARADE, BURWOOD, N.S.W.

INDEX TO ADVERTISEMENTS

FRONT SECTION

Australasian Mutual Insurance Society ... iv

C.O.R. vii

Commonwealth Serum Laboratories ... x

Dunlop Perdriau Rubber Coy. Ltd. ... ix

Gippsland & Northern Co-operative Coy. Ltd. (Separators) iv

Leggo, Victor, & Farmers Ltd. ... ...cover

H. V. McKay Massey Harris Pty. Ltd. ... iii

Robinson, T. & Co. Pty. Ltd. ii

Trewhella Bros. Pty. Ltd. iv

Vacuum Oil Coy. Pty. Ltd. v

BACK SECTION

Australian Cement Ltd. ... ...cover

Government Cool Stores xvii

Lysaght Bros. & Coy. Ltd. xiii

Red Poll Stock for Sale xvi

Rylands Bros. (Aust.) Ltd. xi

Shell Coy. of Australia Ltd. xi

State Savings Bank xiv

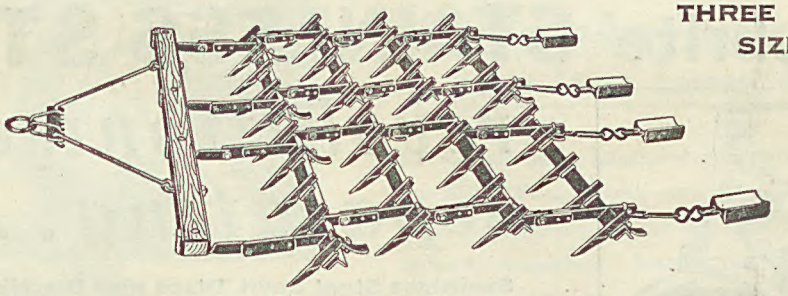
Texaco Tractor Oil xv

Victorian Dried Fruits Board ... ...cover

Victorian Railways xv

THE NEW

SUNMULCH HARROW



THREE SIZES

Self-Cleaning and Seed-Bed-Forming

An outstanding patented harrow and winner of the special prize at the Melbourne Centenary Royal Show for the best farm implement developed during the year. The unique self-cleaning feature—found only on the Sunmulch—forces the rubbish over the rear, and eliminates frequent delays and laborious work. As a seed-bed-forming harrow it leaves a firm seed-bed, and a mulch for the reception of rye-grass and clover seed, &c., while the native grasses are not destroyed.

Special features—mounting tynes OVER the beam—and tynes re-dressable to prolong wear—adjustable depth of cultivation by shoes or on each tyne—are described with others in an illustrated folder—free on request—with prices and terms. Ask the local agent for a copy, or write to

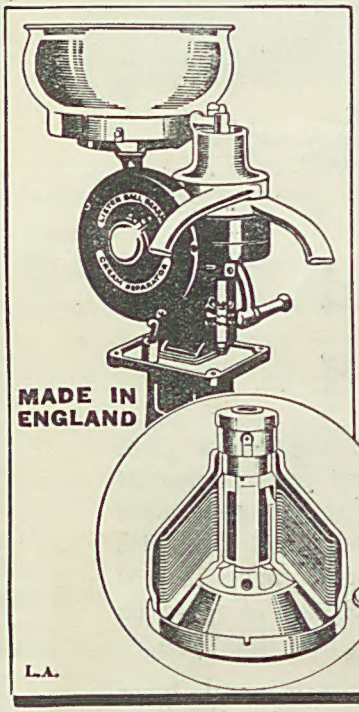
H. V. McKAY MASSEY HARRIS Pty. Ltd.

SUNSHINE HARVESTER WORKS, SUNSHINE

Is a simple arrangement that multiplies the power at the handle 260 times—handy to use, easy to move, quickly rigged, and works in roughest country. Standard equipment pulls trees and stumps from 1½ acres without changing anchor. Many other time- and labour-saving features. Catalogue with pleasure.

TREWHELLA BROS. PTY. LTD., TRENTHAM

"Staybrite" STAINLESS STEEL



revolutionises separating . . .

Stainless Steel Bowl, Discs and Distributor ...Ball-Bearing Spindle (exclusive design) ...Amazing skimming efficiency...Easy to turn . . . Easy to clean. Lasts a lifetime. Small deposit. Easy monthly payments. Generous allowance old machines.

Write for descriptive literature "L.1," stating capacity required.

GIPPSLAND & NORTHERN Co-op. Co. Ltd.,
Machinery Department:
607-613 Collins St., Melbourne, C.1. G.P.O. Box 4556

Lister

ALL-BRITISH
BALL-BEARING CREAM SEPARATOR

The Australian Alliance Assurance Company
in which is merged

Phone: 1051 Central (4 lines)

The Australasian Mutual Insurance Society

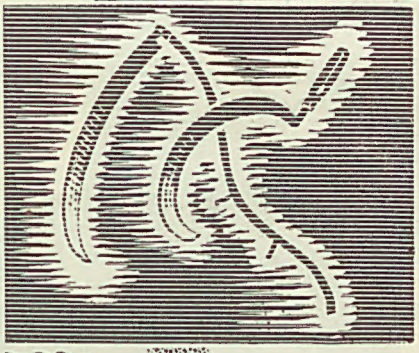
400-2 COLLINS STREET, MELBOURNE

LIVE STOCK INSURANCE
At Lowest Current Rates Obtainable in Australia

Insure with this Society and recommend it to your Neighbours

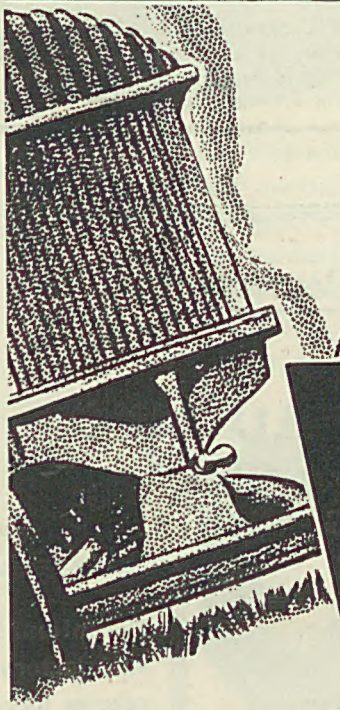
Other Departments of Business
Fire, Marine, Fidelity Guarantee, Plate Glass, Personal Accident and Sickness, Employers' Liability, Workmen's Compensation, Public Risk, Motor Car, and Burglary.

YESTERYEAR IT WAS THE POWER BEHIND THE SICKLE...



TO-DAY maximum tractor power means lower harvest costs

As the harvester improved upon sickles, so is the NEW Voco Power such a vast improvement on ordinary tractor kerosenes as to be instantly recognized. Smooth, eager, absolutely knockless, maximum power and minimum consumption spell the one important thing—ECONOMY—more work from a gallon than you've ever had before. Use Mobiloil, too, the world's finest tractor oil and Voco's best power-partner



VOCO POWER KEROSENE

FOR POWER AND ECONOMY

13919.—2

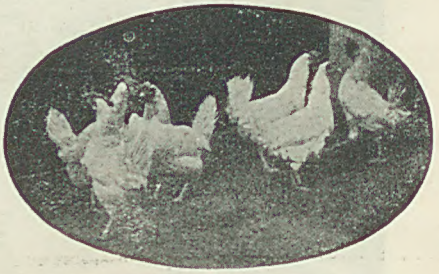
DEPARTMENT OF AGRICULTURE

White Leghorn and Australorp Eggs . .

FOR SETTING

Settings of White Leghorn and Australorp Eggs will be available from the State Research Farm, Werribee, during JULY, AUGUST, and SEPTEMBER.

Eggs from single-mated birds	**2 gns. a sitting of 16**
Eggs from hens mated to pedigreed cocks ..	**1 gn. a sitting of 16**



Apply to—

The Manager, State Research Farm, Werribee

For Better Results from the Rural Districts—

consider the

Journal of Agriculture

as a medium to carry YOUR ADVERTISING

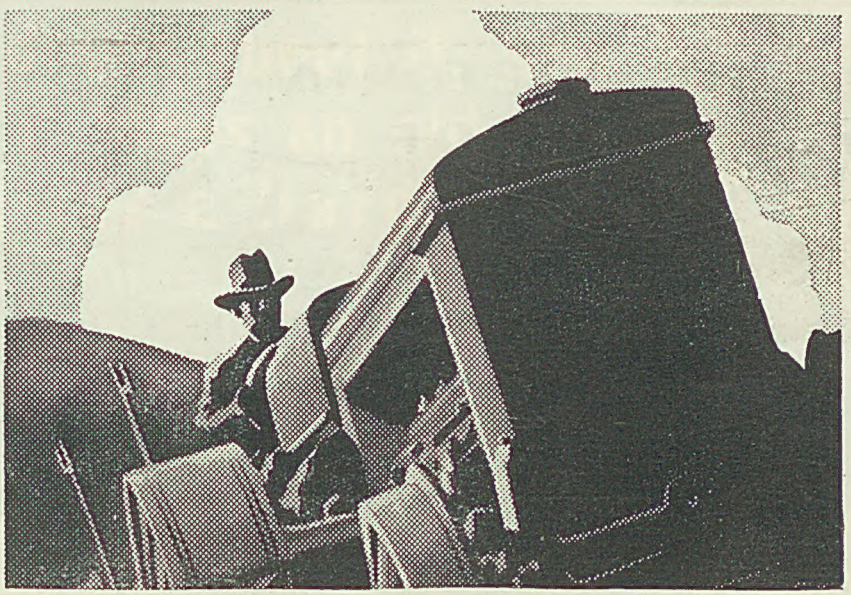
REACHING 10,000 homesteads in the rural districts of Victoria, this Journal is read, from cover to cover, by farmers and their families for its articles of authentic information dealing with every phase of primary production.

No other paper in the State can offer a group of potential buyers so large or so influential

Exceptionally satisfactory results have followed the advertising of Stud Stock in this Journal

Rates on application to the Official Canvasser,

DEPARTMENT OF AGRICULTURE, MELBOURNE, C.2



This BETTER tractor fuel is BRITISH

As Britain is Australia's best customer it is fair enough to suggest that Australian primary producers should use a British-Australian tractor fuel. And by using "C.O.R" Power Kerosene you'll work more acres per gallon and gain smoother, trouble-free running.

Available in convenient 24-gallon drums.

"C.O.R"

NEW PROCESS

P.K.12/A

POWER KEROSENE

The Commonwealth Oil Refineries Limited. (Commonwealth Government & Anglo-Persian Oil Co. Ltd.)

THE VICTORIA STUD OF FRIESIAN CATTLE

State Research Farm, Werribee.

BULL CALVES

For Sale at Reduced Prices

(For a limited time only)

The prices of VICTORIA Friesian bull calves offered at the State Research Farm, Werribee, are now based on the average butter-fat production of the dam for all 273-day lactation periods performed under the Standard Herd Test, at the following rates:—

When the average exceeds 500 lb. butter-fat .. .. .. 1/- per lb.
When the average lies between 450 and 499 lb. butter-fat .. 11d. per lb.
When the average lies between 400 and 449 lb. butter-fat .. 10d. per lb.
When the average is below 399 lb. butter-fat .. .. 9d. per lb.

Untested heifers' bull calves - - 10 guineas each

Maintenance charges added to bulls over 12 months old. Prices quoted are f.o.r. Werribee.

These new prices are similar to those fixed for the sale of pure-bred bull calves under the Government Subsidy Scheme. The prices formerly charged were based on the dams' highest butter-fat record (365 days) at 1/- per lb.

VICTORIA JOYOUS PATCH (C.R.) *Born:* 31st January, 1934 **14 gns.**

Sire: Victoria Joyous Mercedes (985) *Dam:* Victoria Top Patch (2634) *Gdam:* Victoria Lean Patch (1705)

Victoria Top Patch has produced 318, 398, 459, 401, and 383 lb. butter-fat in 273 days—All lactations—Average: 392 lb. butter-fat. Price of bull calf—392 by 9d equals 14 guineas.

Victoria Lean Patch has produced 326, 306, 577, 506, 700, 592, 511, and 538 lb. butter-fat in 273 days. Average: 507 lb. (Records not considered in price of calf.)

A limited number of Friesian females also for sale

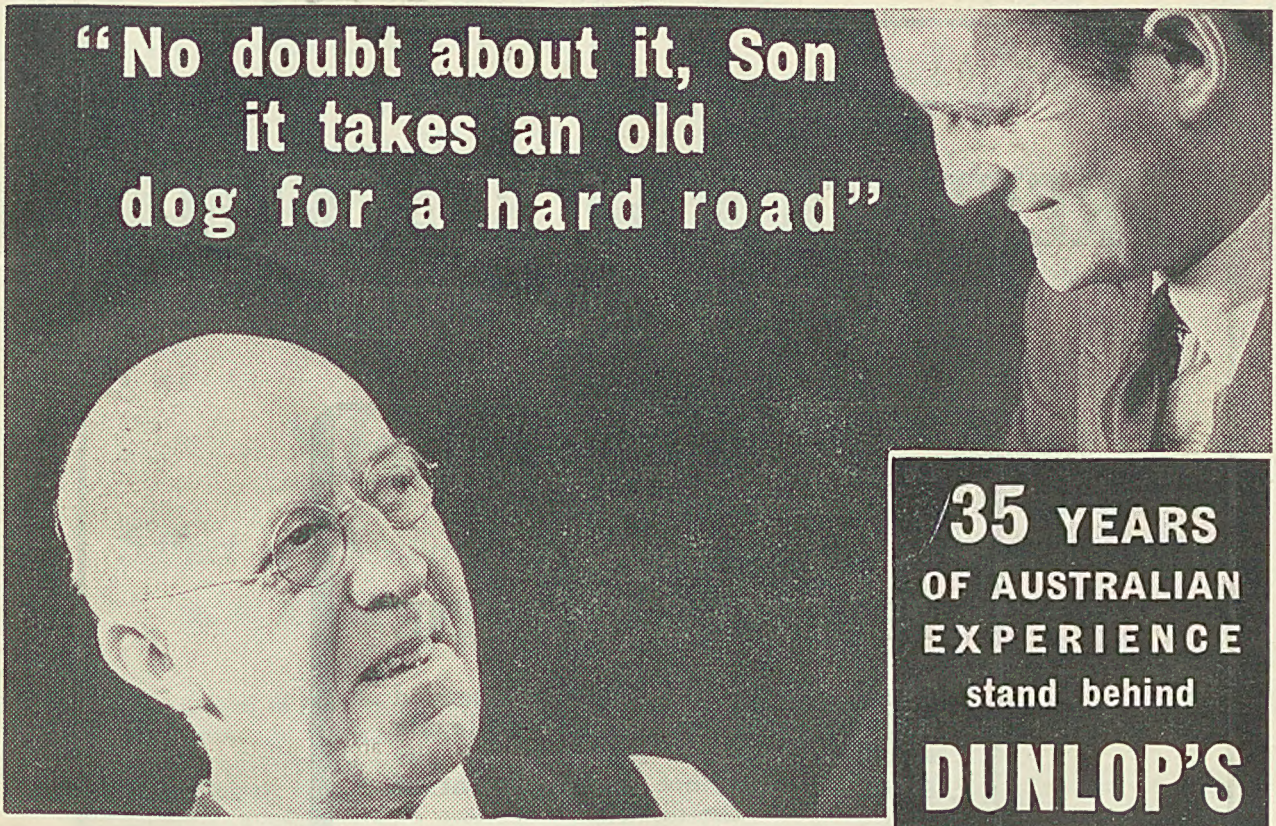
THE HIGHEST PRODUCING FRIESIAN HERD UNDER TEST

Registered - - Herd-Tested - - Tuberculin-Tested

For Further Particulars apply to—

THE DIRECTOR OF AGRICULTURE, MELBOURNE, C.2,
OR THE MANAGER, STATE RESEARCH FARM, WERRIBEE

"No doubt about it, Son it takes an old dog for a hard road"

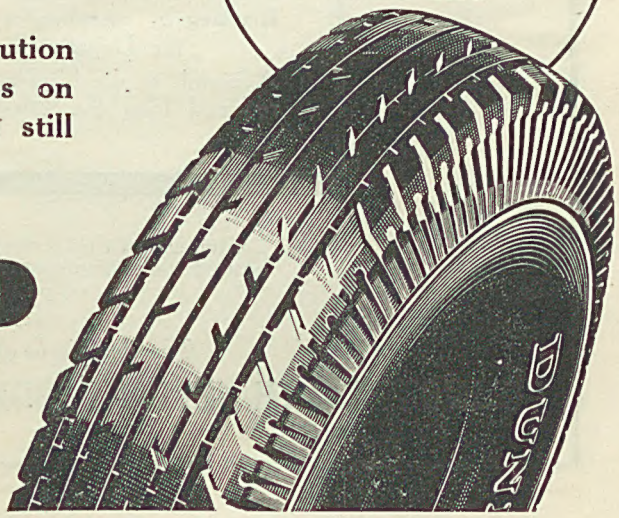


35 YEARS OF AUSTRALIAN EXPERIENCE stand behind DUNLOP'S

48% increased non-skid life

Dunlop's 35 years of Australian experience cannot be equalled by any other tyre manufacturer. No wonder, then, that Dunlop's 48% increase in non-skid life—all those extra thousands of safe miles—are sure and certain under Australian conditions.

Take your share in this wonderful contribution to motoring economy. Put new Dunlops on your wheels—while your local dealer can still quote the lowest prices in tyre history.



DUNLOP

Gold Seal

COMMONWEALTH DEPARTMENT OF HEALTH

PREVENTION of BLACKLEG
IN CATTLE AND SHEEP

Do your stock suffer from this disease? Adopt measures to control it by using the

"COMMONWEALTH"
BLACKLEG VACCINE

This vaccine has been given an extended trial throughout Australia with highly satisfactory results. It is used for the prevention and not the treatment of the disease.

PRICE: 10 doses, 4/-; 20 doses, 7/-; 50 doses, 16/-; 100 doses, 30/-

Order the 50-dose and 100-dose containers only when you have sufficient animals assembled to permit the contents being used up when the containers are opened. When ordering, specify whether for cattle or for sheep.

Before ordering, make certain the disease is Blackleg by consulting a Veterinary Surgeon or the Department of Agriculture.

A permit to use blackleg vaccine in Victoria is required from the Department of Agriculture.

Containers will be forwarded per train or post as desired immediately on receipt of order. Freight or postage extra

The vaccine is obtainable from the

COMMONWEALTH SERUM LABORATORIES, PARKVILLE, N.2, VIC.

NATIONAL MUSEUM OF VICTORIA

The Journal of the DEPARTMENT of AGRICULTURE of VICTORIA

"Bleached" Wheat

Effect of Heavy Rain on Unharvested, Mature Grain

By W. R. Jewell, M.Sc., F.I.C., Agricultural Research Chemist, and W. B. Miller, M.Agr.Sc., Senior Inspector of Agriculture.

THE method of harvesting wheat in Australia by means of a header or harvester necessitates a thorough drying-out of the grain before operations can be commenced. Should rain intervene when the crop is ready for harvesting or after harvesting has commenced, the grain must be left standing in the ear until it has dried enough to permit threshing. Slight showers have little or no influence, but, in occasional seasons, exceptional rains are experienced during this period and harvesting is delayed sometimes for weeks. The effect of this thorough wetting of the grain followed by a period of drying in the ear is to produce what is known as "bleached" wheat. Such wheat has, as the name indicates, a bleached appearance, being paler and less vitreous than similar grain not exposed to such weathering.

In addition to bleaching, exposure to rain of ripe wheat is known to lower the bushel weight appreciably. Such wheat is viewed with suspicion by wheat buyers and millers, and usually is sold at a discount. It is thus a matter of interest to determine whether lowered bushel weight and inferior appearance are the only detrimental effects, or whether bleaching actually results in general deterioration or has any adverse influence on flour yield and baking quality. Heavy rain at harvest is known to cause a certain amount of loss due to flattened and tangled crops, accompanied by the shedding of ripe grain when high wind or hail accompanies the rain. Apart from losses due to these causes, it is stated in some quarters that rain produces a further loss in weight by actually leaching material from the grain itself.

The 1930–31 and 1933–34 harvests, in certain districts in Victoria, were interrupted by very heavy rains, in many cases exceeding 4 inches. Samples were collected, by officers of the Agricultural Division, of wheat harvested just prior to the rain and of bleached wheat from the same paddock harvested after the rain and subsequent drying in the ear. A considerable number of sets of such samples was submitted and, because each set represents one variety of wheat grown under identical conditions except for the delayed harvesting, provides comparable material on which to determine the effects of bleaching on physical and chemical properties of the grain. This report records the results of analytical, milling and baking tests on these samples and indicates the conclusions which may be drawn from the investigation.

While a considerable amount of information is available, particularly in American literature, as to frost injury and the effects of "sprouting" on grain, very little has been published on the effects of the type of weathering at present under consideration, in which sprouting of the grain is absent—at least in all the samples examined.

Whitcomb and Johnson (*Cereal Chemistry*, 5, 1928, 117 and 7, 1930, 162) have investigated the effects of severe weathering on certain properties of wheat. They, however, did not deal

with wheat which had been exposed to rain while standing but with wheat, in the sheaf or threshed, weathered during winter and exposed to rain and snow. Even so, it is interesting to note that, apart from colour, lowered bushel weight and impaired germination, they found this severe weathering to have no serious effect on quality.

Bracken and Bailey (*Cereal Chemistry*, 5, 1928, 128) made an exhaustive investigation on the effect of delayed harvesting on quality of wheat. Six cuttings, covering 50 days after the first harvesting at maturity, were made and the crop was subject to showers during this period. They concluded that "dark, hard wheat of the Turkey Red type does not deteriorate in quality upon standing uncut in the field when subjected to alternate wetting and drying, in spite of the fact that the grains bleach and lose weight per measured volume."

Samples Analysed.

In all, some thirty sets of samples were examined in the two seasons, covering a number of districts and a still greater number of varieties. To give all the results here would be needless repetition; typical examples are given sufficient to indicate the type of result and to substantiate the conclusions drawn. "Unbleached" samples are from bags harvested prior to rain and "bleached" samples are of wheat harvested after the rain. The actual rainfall is given, as accurately as can be ascertained. In general, rain fell on several consecutive days and the figure represents the total fall, most of which was concentrated in one, or at most, two, days.

Physical and Chemical Tests on Wheat.

The results of chemical and physical tests on the wheat samples are given in Table 1. From these

Table 1.—Chemical and Physical Analyses of Wheat Samples.

No.	Variety.	Sample.	Points Rain.	Moisture.	Bushel Weight.	Weight per 500 Grains.	Protein.
				%	lb.	grams.	%
		Rutherglen District, 1930–31 *Season.*					
1	Penny	Unbleached ..	390	11·40	65·5	22·95	8·66
2	„	Bleached		10·90	62·5	24·34	9·54
3	Waratah ..	Unbleached ..	390	10·57	63·1	17·49	9·11
4	„ ..	Bleached		11·10	59·6	18·21	8·70
5	Bena	Unbleached ..	390	11·63	64·6	24·25	10·57
6	„	Bleached		10·50	63·0	23·17	10·79
7	Waratah	Unbleached ..	390	10·87	65·2	20·82	8·76
8	„	Bleached		10·97	61·8	19·52	11·49
		Swan Hill District—After Two Successive Lots of Rain, 1930–31 *Season.*					
9	Nabawa	Unbleached ..	169	10·37	62·6	23·16	12·05
10	„	Bleached		10·87	60·1	22·93	10·95
11	„	Bleached further ..	205	10·77	59·1	22·38	11·77
		Walpeup District, 1933–34 *Season.*					
12	Ranee 4H ..	Unbleached ..	415	9·51	64·2	16·95	10·74
13	„ ..	Bleached		10·40	59·3	17·98	8·30
14	„ ..	Unbleached ..	420	9·99	63·1	16·61	11·65
15	„ ..	Bleached		9·77	58·0	17·35	11·49
16	Rajah	Unbleached ..	402	10·32	60·9	16·18	11·41
17	„	Bleached		9·97	53·3	14·70	10·32
		Rutherglen District, 1933–34 *Season.*					
18	Free Gallipoli ..	Unbleached ..	800	9·85	61·2	19·19	10·49
19	„ ..	Bleached		10·17	55·3	19·27	8·42
20	Ghurka	Unbleached ..	550	10·65	59·9	19·41	8·79
21	„	Bleached		8·89	57·0	17·91	9·38
		Dookie District, 1933–34 *Season.*					
22	Joffre	Unbleached ..	400	10·21	62·3	19·00	12·01
23	„	Bleached		9·47	59·0	19·56	10·97
24	Ranee 4H ..	Unbleached ..	400	10·66	63·9	16·75	9·34
25	„ ..	Bleached		10·55	60·7	17·88	9·00
26	Free Gallipoli ..	Unbleached ..	400	11·21	60·6	22·38	8·06
27	„ ..	Bleached		10·71	57·8	22·15	8·18

TABLE 2.—MILLING AND BAKING TESTS OF WHEAT SAMPLES.

No.	Variety.	Sample.	Flour Yield.	Protein in Flour.	Wet Gluten	Dry Gluten.	Maltose.	Loaf Volume.
			%	%	%	%	Milligrams per 10 grm.	c.c.
1	Penny	Unbleached ..	73·7	..	22·6	7·3	..	1,700
2	„	Bleached ..	73·3	..	23·4	7·9	..	1,840
3	Waratah ..	Unbleached ..	73·7	..	21·5	7·6	..	1,900
4	„ ..	Bleached ..	73·4	..	20·0	7·1	..	1,820
5	Bena	Unbleached ..	78·3	..	27·5	9·6	..	1,720
6	„	Bleached ..	77·5	..	28·5	9·5	..	1,780
7	Waratah ..	Unbleached ..	74·8	..	23·3	7·8	..	1,740
8	„ ..	Bleached ..	74·2	..	32·3	10·4	..	1,970
9	Nabawa ..	Unbleached ..	76·5	..	37·1	11·7	..	1,840
10	„ ..	Bleached ..	76·0	..	27·3	9·2	..	2,040
11	„ ..	Further bleaching	76·6	..	33·7	10·1	..	2,200
12	Ranee 4H ..	Unbleached ..	67·4	8·70	24·9	8·7	168	1,640
13	„ ..	Bleached ..	69·4	6·82	15·8	5·8	142	1,640
16	Rajah	Unbleached ..	68·7	9·70	27·6	9·0	99	1,560
17	„	Bleached ..	65·2	8·58	21·4	9·7	95	1,460
18	Free Gallipoli ..	Unbleached ..	72·3	8·38	25·3	8·7	118	1,460
19	„ ..	Bleached ..	72·4	6·70	21·2	6·8	370	1,570
22	Joffre	Unbleached ..	69·2	9·74	27·1	9·1	93	1,680
23	„	Bleached ..	70·7	9·18	20·5	6·7	345	1,770

data it is suggested that the following conclusions may be drawn :—

Moisture.—Differences in moisture content are negligible and inconsistent as between bleached and unbleached wheat. This indicates that the bleached samples have been dried out, either before harvesting or during subsequent storage, to approximately the same moisture content as the normal samples.

Bushel Weight.—Bushel weight is consistently and markedly reduced by exposure to rain and subsequent desiccation. The amount of reduction varies considerably, the lowest being 1·6 lb., and the highest the remarkable figure of 7·6 lb., the mean reduction being 3·8 lb. The three samples (Nos. 9, 10 and 11) from Swan Hill are interesting in that the first rain caused a reduction in bushel weight of 2·5 lb., while the second and heavier rain caused a further reduction of only 1 lb. Bracken and Bailey (loc. cit.) record a somewhat similar result and suggest that 69 points was sufficient to produce a maximum reduction in density, further showers having no marked effect. They, however, were dealing with material which was subject to light showers only.

Weight per 500 grains.—In each case the figure for the weight per 500 grains is the mean of three separate weighings consistent within themselves. Differences in weight are small and are sometimes in favour of bleached and sometimes in favour of unbleached samples. This inconsistency would suggest that these slight differences are not due to varying proportions of small grain resulting from altered adjustment of the harvester after rain, but more probably to variations in the effect of rain on the different sets. In general it is evident, therefore, that exposure to rain and subsequent drying in the ear produce no significant reduction in the actual weight per grain. As weight per grain remains constant, the marked reduction in bushel weight must be due to an increase in volume of the kernel. Bracken and Bailey and others have recorded similar results and have shown that this increase in kernel volume is due to the development of cracks inside the kernel as the result of thorough wetting followed by drying. In addition to producing an increase in volume, such cracks would cause a difference in the refraction of light and would allow the entrance of air, thus tending to make the appearance of bleached grain more opaque or starchy than that of normal grain.

Protein.—Differences in protein content are in most cases slight, but in a few cases are significant, although not always in favour of the unbleached samples. It is probable that these differences are due to sampling errors or to differences in maturity before and after rain rather than to any leaching effect of the rain itself. If the latter were the more probable explanation, one would expect a more general reduction in the protein of bleached samples.

MILLING AND BAKING TESTS.

Selected pairs of samples were milled in the departmental experimental flour mill and the

resultant flour was subjected to analysis and to a standard baking test. A detailed account is not necessary here, except to say that conditions are rigidly standardized so that the flour itself is the only variable. The results of these tests are given in Table 2, from which the following deductions may be drawn :—

Contrary to what might at first glance be expected, flour yield is not adversely affected to an appreciable extent by bleaching, whether calculated as a percentage of the mill products produced or as a percentage of the original weight of wheat taken. The one marked exception is in the case of the sample having the phenomenally high reduction in bushel weight of 7·6 lb. It is generally held that flour yield is correlated with bushel weight, the lower the latter the lower the flour yield. The seeming anomaly with these bleached samples, with their marked reduction in bushel weight, is explained by the fact that the lowered bushel weight is, in these cases, not due to a reduction in weight per kernel.

Baking quality, as measured by loaf volume, is not appreciably affected by bleaching. In many cases the bleached sample gives a higher loaf volume than the unbleached. The three samples (Nos. 9, 10, and 11) are again interesting, in that loaf volume shows a progressive increase with each wetting. In some cases the quantity and the quality of the gluten appears to have been affected by bleaching, but apparently not sufficiently to interfere with baking quality as measured by loaf volume.

Diastatic capacity is the power of a flour to provide yeast food during fermentation or proving and is measured as the milligrams of maltose per 10 grams of flour produced by the diastase present under certain defined conditions. Sprouted grain has a very high diastatic capacity, but grain which has been wetted would not necessarily be expected to be high in this respect unless some sprouting had taken place. The maltose figures for samples 12, 13, and 16, 17, show no increase through bleaching, but the final two sets in Table 2 show a threefold increase due to bleaching, which is reflected in loaf volume. It is probable that some of the other cases where loaf volume of bleached samples is higher than that of unbleached, are due to increased diastatic capacity.

Conclusions.

This investigation definitely indicates that, apart from lowered bushel weight and bleached appearance, exposure of ripe grain in the ear to heavy rain followed by drying before harvest, has no appreciable deleterious effect on flour yield, baking quality or other characteristics. It further indicates that rain does not leach out soluble constituents, with a consequent reduction in grain weight, and that therefore there is no appreciable lowering of yield from this cause.

Book Review

The Veterinary Journal (Special Dairy Cattle Number, July 1934)

—Baillière, Tindall and Cox, London—2/-

THE Editors are to be congratulated on their practice of devoting special numbers of their Journal to a series of articles dealing with one type of animal.

Any one who has attempted to keep abreast of recent advances in knowledge of stock and their diseases, and has found the contributions to the subject widely scattered in a number of different Journals and languages, will appreciate the presentation of the matter in such a readily accessible form.

The first general article by the Veterinary Adviser to the National Federation of Meat Traders, Lt.-Col. Dunlop Young, describes the type of carcass preferred by the British consumer, and indicates the various breeds of cattle which will produce it. Coming, as it does, from such an authoritative source, it should prove of great value to cattle-breeders in Australia who wish to cultivate the British market as an outlet for their surplus products.

The articles which follow describe various British breeds of Beef, Dairy, and Dual-purpose cattle, and bring forward the best qualities of each breed, and the special uses for which they are suitable. These should aid cattle-breeders in Australia to determine which breed is best suited to the conditions which exist in their districts.

The articles of a purely veterinary nature, and more particularly those which deal with Mastitis, Black Spot, and Milk Fever, contain information of considerable interest to the Australian practitioners and to the official veterinarian.

R. N. JOHNSTONE.

Fumigation of Citrus Trees

— *Part II.* —

By J. L. Provan, B.Agr.Sc., Horticultural Research Officer.

The first portion of this article appeared in the December, 1934, issue of this Journal, and included a brief résumé of the departmental activities in the control of red scale by fumigation, a description and life history of red scale, the use of calcium cyanide as a fumigant, method of fumigating, and fumigation equipment and the preparation of the grove prior to fumigation.

IT has been stated previously that the toxicity of cyanogen is undoubted, provided that the conditions under which it is employed allow the lethal concentration to be maintained for a sufficiently long period. It is now proposed to consider this concentration and the factors influencing it.

Factors Influencing the Concentration of Gas.

Dosage.

In Victoria, the usual practice in fumigation operations is to describe the relation between the desired weight of the fumigant and the volume of the space to be fumigated, as a dosage, expressed in ounces or grams per 100 cubic feet. The latter method is employed when Calcid Briquettes are used, because each briquette weighs 20 grams. Actually, the dimensions of the covered tree are shown on a dosage chart, and the volume is seldom included. Opposite the particular dimensions of the tree the dosage of calcium cyanide is read, in ounces for Cyanogas "A" dust, and in number of briquettes for the Calcid Briquette method (see Tables 2 to 8).

In calculating these dosages, many factors have been taken into consideration, of which chemical composition of the material and the volume of the covered tree are the two most important. But humidity and leakage from the tent must be considered also, and in the case of the latter, provision must be made to compensate for losses in gas concentration.

The chemical compositions of the two principal fumigants in use in Victoria—Cyanogas "A" dust and Calcid Briquettes—have been discussed previously, and the importance of the cyanogen content of these materials has been stressed. It will be noticed that the total cyanogen (CN) content of each of these materials varies widely for the various trees included in Table 1. In the case of the Cyanogas "A" dust, the total cyanogen (CN) content of the dosages is 23·26 ounces, while the total for Calcid Briquettes is only 16·36 ounces, i.e., Cyanogas dosages actually contain an average of 42 per cent. more cyanogen (CN) than the Calcid dosages.

Fig. 6.—Fruit infested with Red Scale. Note the preponderance of female scales.

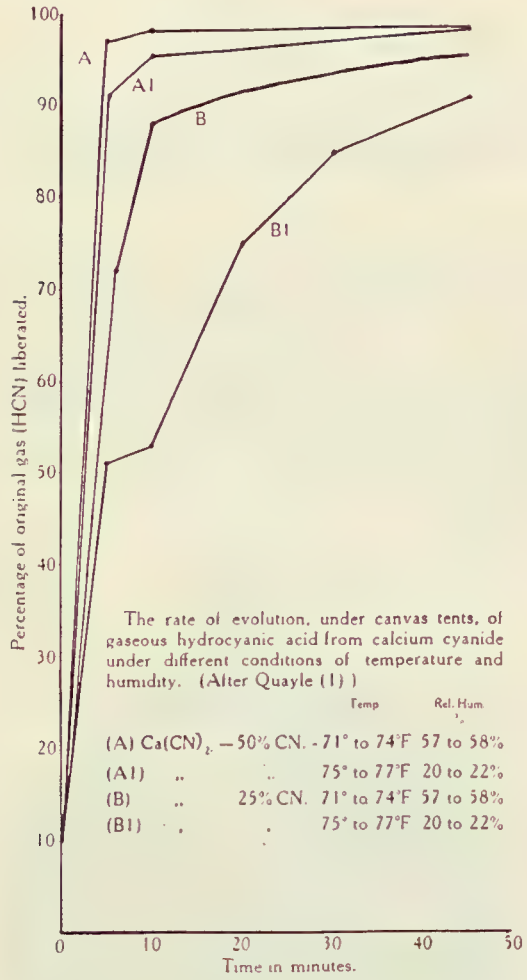

Percentage of original gas (HCN) liberated.
Time in minutes.
A
A1
B
B1
The rate of evolution, under canvas tents, of gaseous hydrocyanic acid from calcium cyanide under different conditions of temperature and humidity. (After Quayle (1))
Temp
Rel. Hum
(A) Ca(CN)2 — 50% CN. - 71° to 74°F 57 to 58%
(A1) .. .. 75° to 77°F 20 to 22%
(B) .. 25% CN. 71° to 74°F 57 to 58%
(B1) .. . 75° to 77°F 20 to 22%

Fig. 7.—The rate of evolution of hydrocyanic acid gas.

This disparity, at first, appears bewildering, particularly as both these substances have given excellent results in fumigation practice in this State. The explanation, of course, is that only approximately 80 per cent. of the cyanogen content is liberated from Cyanogas within the period of time during which the tree remains covered. Also, the evolution of the gaseous hydrocyanic acid from this substance is slower than from the Calcid Briquette method, resulting in a lower initial concentration.

Cyanogas depends upon the slower generation of the toxic gas and the maintenance of a lethal concentration over a long period. This concentration is maintained by the continued and gradual liberation of gas after the initial evolution. Quayle (1) in a series of experiments with calcium cyanide has calculated the percentage of gas liberated for given periods of time. The results of some of these tests, which include a 50 per cent. cyanogen content dust (comparable, in composition, to Calcid Briquettes) and a 25 per cent. dust (similar to Cyanogas "A" dust) are shown in Fig. 7.

Practical fumigators use a dosage table as a guide to the requirements of a particular sized tree; but it is incorrect to assume that they adhere strictly to it, nor would it be advisable to do so. The dosage table must be considered as a basis for further calculations, and frequent modifications, usually expressed as a percentage of the table dosage, are necessary to suit the varying conditions of either environment or tree. The extent of such modifications can be gained only by experience in a particular district, and it is essential that only experienced men should have charge of contracting fumigation outfits.

If the humidity drops below 40 per cent., the foreman of the outfit will know with experience whether a 10 or 20 per cent. increase in dosage is necessary. When it has been established previously that the dosage table being used does not provide sufficient concentration for small trees, or where scale infestation is heavy, it may be necessary to increase the dosage. The vagaries of the weather will require careful and intelligent modifications in the dosages, and as the season advances the foreman may find it necessary to increase the dosages.

These remarks have not been made to confuse the private fumigator, who can quickly learn the requirements of his own grove, and can choose the most favorable climatic conditions to perform the fumigation. The contractor, however, must keep his outfit in operation when conditions are not so favorable, and it is in these circumstances particularly, that experience is essential to success.

The dosage tables appearing in this article provide for some modifications; but it cannot be expected that any one table could make provision for the many exigencies in fumigation. The practice of using one standard table, with modifications to suit local requirements, is recommended.

The chemical composition of the fumigant and its importance have been stressed; but there is a minor factor, which sometimes affects the concentration of the gas. This factor is the difference in composition of the material when it leaves the factory, and at the time it is measured as a tree dosage. Care must be exercised to ensure that the calcium cyanide containers are always tightly sealed. Losses

DIAMETER OF TREE IN FEET.

HEIGHT OF TREE IN FEET.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	HEIGHT OF TREE IN FEET.
4	1	1	1	2	2																		4
5		1	1	2	2																		5
6		1	2	2	2	3	4	4	5	6													6
7		1	2	2	3	4	4	5	6	7	8												7
8			2	2	3	4	4	5	6	8	9	10	12	14									8
9				3	4	5	5	6	7	9	10	12	14	16	18								9
10					4	5	6	7	8	10	11	13	15	18	19	22							10
11						5	6	8	9	11	13	14	17	18	22	24	26						11
12						6	7	8	10	12	14	16	18	21	24	27	29	32	36	40	44	48	12
13								9	11	13	15	17	20	22	25	28	32	34	39	44	48	51	13
14								9	12	14	17	19	22	24	28	33	35	37	43	47	51	55	14
15									12	15	18	20	23	26	30	34	38	42	46	51	55	58	15
16									13	16	19	22	24	28	32	35	40	44	48	54	57	63	16
17										17	20	23	26	30	34	37	43	47	51	56	61	67	17
18										18	21	22	28	31	35	40	44	49	54	60	65	71	18
19										19	22	25	29	33	37	43	48	52	57	63	69	75	19
20										20	24	27	31	35	39	44	50	54	61	66	72	79	20
21													32	36	42	46	52	57	64	70	76	83	21
22													34	39	44	49	55	62	67	74	80	87	22
23													36	41	45	51	57	63	69	77	83	91	23
24													37	43	48	53	60	65	72	79	87	95	24
25														44	50	56	62	67	75	83	91	100	25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

Table 2.—Cyanogas dosage chart No. 1a.—To be used with humidities 60 per cent. and over. Based on height and diameter.

The above chart shows the dosage required for trees of various sizes when approximately 1 oz. to 100 cub. ft. is used. For inland areas or where humidities are under 60 per cent., use chart No. 2a.

from leaky containers are not often apparent and may easily lead to the under-dosing of trees. Providing the containers are air-tight, losses are very small.

The measurement of the dosage of calcium cyanide for each tree should be made carefully and precautions taken to see that the entire dosage is blown under the tent. The latest types of blowers are very efficient, and have been carefully designed to prevent any residue remaining in the machine.

Any attempt to reduce dosages, solely for the purpose of decreasing the cost of fumigation, may result in unsatisfactory kills, and only tends to destroy confidence in a useful weapon of defence against insect pests. A much better practice is to increase the dosage as near as possible to the margin of plant tolerance, in order to obtain a higher percentage kill.

The influence of various factors on the dosage will be dealt with in the following paragraphs, and an estimate can be made of their relative importance.

Humidity.

As the liberation of the cyanogen content of calcium cyanide depends, principally, upon the moisture in the atmosphere, the importance of continuous observation, and recording of relative humidity will be realized. Fig. 7, which shows the effect of different humidities upon the generation of the gas, has been adapted from Quayle's experiments (1). The line marked *B* indicates that ten minutes after the charge has been blown into an atmosphere, the temperature of which is 71° to 74°F. and the relative humidity 57 to 58 per cent., 88 per cent. of the cyanogen content of this dust, which resembles Cyanogas, will be liberated. But at a temperature of 75° to 77° F., and a humidity of 20 to 22 per cent., the same dust will liberate about 53 per cent. only, of its cyanogen content. This is represented by the line *B*1.

The above results were obtained with a calcium cyanide having a cyanogen content of 25 per cent., but if the cyanogen content is 50 per cent. the evolution of the gas naturally will be more rapid. This is shown in Fig. 7, by the line marked *A*, which represents the rate of evolution of the gas at a temperature of 71° to 74° F. and a relative humidity of 57 to 58 per cent. A compound of this composition, which resembles Calcid Briquettes, liberates 98 per cent. of its gas in ten minutes.

DIAMETER OF TREE IN FEET.

HEIGHT OF TREE IN FEET.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	HEIGHT OF TREE IN FEET.
4	1	1	1	2	2																		4
5		1	1	2	2																		5
6		1	1½	2	2½	3	4	5	5	6													6
7		1	2	2	3	3	5	6	7	9													7
8			2	2	3	4	5	6	7	9	10	12	13	16									8
9				3	4	5	6	7	9	10	12	13	16	18	19								9
10					5	6	8	8	10	12	13	15	18	19	21	25							10
11						6	7	9	11	12	14	16	19	21	25	27	30						11
12						6	8	9	12	13	15	18	21	24	27	30	33	36	40	45	49	54	12
13								10	12	15	18	19	22	25	28	31	36	39	43	49	54	57	13
14								10	13	15	18	21	24	27	31	34	39	42	48	52	59	61	14
15									14	17	20	22	26	28	33	37	42	46	51	57	61	66	15
16									15	18	21	24	27	31	34	39	45	49	54	60	64	70	16
17										19	22	25	28	33	37	42	48	52	57	63	67	75	17
18										20	24	27	31	34	39	45	50	55	61	67	73	79	18
19										21	25	28	33	37	42	48	54	58	64	70	78	84	19
20										22	27	30	34	39	43	50	55	61	69	75	81	88	20
21													36	40	46	52	58	64	72	78	85	93	21
22													37	42	50	55	61	67	75	82	90	97	22
23													39	46	51	57	64	70	78	85	93	102	23
24													40	48	54	60	67	73	81	88	97	107	24
25														50	55	63	69	76	84	93	102	109	25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

Table 3.—Cyanogas dosage chart No. 2a.—To be used with humidities under 60 per cent. Based on height and diameter.

The above chart shows the dosage required for trees of various sizes when approximately 1 oz. to 90 cub. ft. is used. For coastal areas or where humidities are over 60 per cent., use chart No. 1a.

DISTANCE AROUND IN FEET.

DISTANCE OVER IN FEET.

	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48		30	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
20	4½	5½	5½	6	6	6	6	7	7	8	8	8				20																20
22	4½	6	6	6	7	7	7	7	7½	8	9	9	9	11		22																22
24	5½	6	6	6	7½	7½	7½	8	8	9	9	9	11	11		24																24
26			7	7½	7½	8	9	9	9	11	11	11	12	12	12	26	14															26
28				7½	8	9	9	9	11	11	12	12	14	14	14	28	15															28

	28	30	32	34	36	38	40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
30	9	9	11	11	12	12	14	14	15	15	17	30	19	19	20	20	20											30
32			11	12	12	14	15	15	17	17	19	32	20	22	22	22	23	23										32
34			12	14	15	17	19	20	20			34	22	23	23	25	25	26	26	28								34
36			14	15	17	19	20	22	22	23		36	25	25	26	26	26	28	30	30	31							36
38				17	19	20	22	23	25	25		38	26	26	28	30	30	31	31	33	33	34	36					38
40						40	42	44	46	48		40	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
42						22	23	25	26	26		42	28	30	31	31	33	33	34	36	36	37	37					42
44							25	26	28	30		44	31	31	33	34	34	36	37	37	39	39	41	42				44
46								26	30	31		46	33	34	34	36	37	39	41	42	44	44	45	47	47			46
48									30	33		48	36	37	39	41	42	44	45	47	48	50	50	51	51	53		48
										34			37	39	41	42	44	45	47	48	50	51	53	55	56	58	59	

	12	14	16	18	20	22	24	26	28	30	32	34	36	38			50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
10	1½	1½	2	2	3										10	50	39	41	42	44	45	48	50	51	53	55	58	59	61	64	66	50
12	2	2	2	3	3	4	4								12	52				47	50	53	55	56	58	59	64	68	69	72	74	52
14	2	2	3	3	4	4	4½	4½	4½	5½	6	6	6		14	54					53	56	59	62	66	69	72	74	76	77	80	54
16	3	3	3	4	4	4½	4½	5½	5½	6	6	6	7	7½	16	56						59	64	68	72	76	77	80	83	84	87	56
18	3	3	3	4	4½	4½	6	6	7	7	7	7½	7½	7½	18	58						62	69	72	79	84	85	88	95	98	100	58

Table 4.—Cyanogas dosage chart No. 1.—To be used with humidities of 60 per cent. and over. Based on over and around measurements.

The above chart shows the dosage required for trees of various sizes when approximately 1 oz. to 100 cub. ft. is used. For inland areas or where humidities are under 60 per cent., use chart No. 2.

The humidities, in the northern parts of Victoria where the major citrus districts are situated, are frequently low, and it is likely that these low humidities have been responsible for the poor fumigation results, which are sometimes experienced. When the temperature is less than 80° F. and the humidity drops below 40 per cent., it is a good practice, when fumigating with calcium cyanide, to increase the dosage.

Humidities of from 40 to 80 per cent. are favoured for fumigation work; but, in some cases, 80 per cent. may be exceeded, providing the temperature is below 70° F. The average humidity in the Mildura district, at 9 p.m., for the past 22 years, has been 41 per cent. for January, and 44 per cent. for February, rising to 51 per cent. in March. The average temperature during these months is 76°, 76°, and 70° F., respectively. This district may be taken as typical of the far northern areas, and it will be realized that for an average humidity of 40 to 44 per cent. to be maintained, long periods of lower humidities must occur frequently.

When the humidities are low, it is often necessary to increase the dosage, and in the Cyanogas tables (Tables 3 and 5), these corrections have been made for humidities under 60 per cent. In the case of Calcid Briquettes (Tables 7 and 8), no correction is made for humidity, because this form of calcium cyanide liberates practically all its cyanogen content under the climatic conditions usually found in practice. Dr. Peters (2) states that providing the relative humidity at a given temperature exceeds the figures given below, it is sufficient for the normal Calcid Briquette dosage.

Temperature	85° F.,	20%	relative humidity.
,,	77° F.,	26%	,, ,,
,,	68° F.,	35%	,, ,,
,,	59° F.,	47%	,, ,,
,,	50° F.,	64%	,, ,,
,,	45° F.,	80%	,, ,,

When fumigating small trees it is preferable to work with higher humidities than when fumigating large trees, because a higher dosage of calcium cyanide per unit volume of the tree must be given. This aspect will be discussed under the heading—"Porosity of the Tent."

An important point in measuring humidities is the position of the wet and dry bulb thermometers. They should be placed on the shady side of the tree, and should be free from the influence of surrounding objects. Also, they should be tested frequently by comparison with standard instruments.

Application of the Dust.

With the two methods of fumigation under discussion, the particle size of the dust, and its dispersion under the tent, have an important effect on the evolution and concentration of the gas. Both the Cyanogas "A" dust, and the Calcid Briquette, after it has been ground to a dust in the machine, have extremely fine particles and when these are blown into the atmosphere the generation of the gas commences immediately.

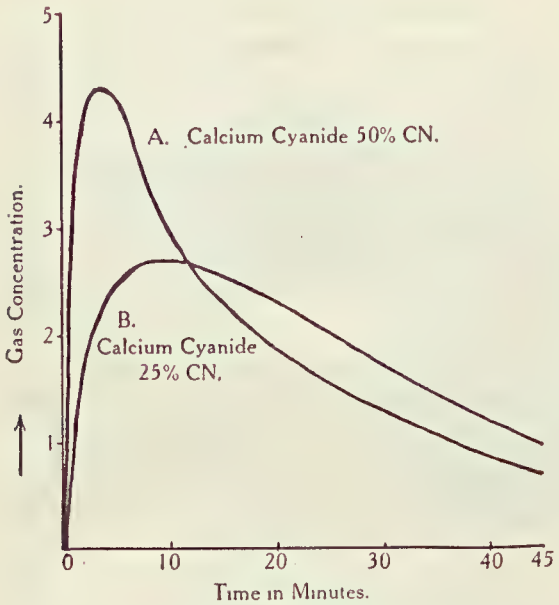


Fig. 8.—Concentration of hydrocyanic acid gas.

The uniform distribution of the dust throughout the foliage of the tree is important, and much attention has been given to the nozzles of the blowers to ensure that the dust is evenly distributed. The best practice in applying the dust is to endeavour to form, near the soil surface, a good cloud which gradually rises and filters through the foliage. Gaseous hydrocyanic acid, being lighter than air, tends to rise, and therefore any attempt to blow the gas to the top of the tree, will result in a higher concentration in this region to the detriment of the concentration nearer the soil level. A more uniform distribution will be obtained by allowing the slow, natural, upward diffusion of the gas to take place.

When the dust is spread in thin layers beneath the tree the rate of evolution of the gas is very much reduced, and heavier dosages are necessary to maintain a sufficiently high concentration which will be toxic to the scale. This method has the advantage, however, of eliminating the deposit of dust on the fruit. As will be seen later, this aspect is important when lemons are fumigated.

Rapidity of Evolution.

The rapidity of the evolution of cyanogen and the maintenance of the concentration for a period of time are depicted in Fig. 8. While this figure is not a graph of actual results of trials in Victoria, it is based on work by Quayle (1) and Peters (2), and serves to illustrate the types of evolution and concentration of gases obtained from 50 and 25 per cent. calcium cyanide respectively.

In the case of A, $Ca(CN)_2$ 50 per cent. (CN), the maximum concentration of gas is obtained in from three to four minutes and then falls rapidly, largely due to leakage from the tent. The curve B representing the 25 per cent. (CN), calcium cyanide, shows that maximum concentration never reaches the level of the 50 per cent. (CN), calcium cyanide, because the generation of gas is much slower, but its concentration is maintained for a longer period.

DISTANCE AROUND IN FEET

DISTANCE OVER IN FEET.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	DISTANCE OVER IN FEET.
20	5	5½	6	6½	7	7	7	7½	7½	8	8	8½																			20
22	5	6½	7	7	7½	7½	7½	7½	8	8½	10	10	10	12																	22
24	6	7	7	7	8	8	8	8½	8½	10	10	10	12	12																	24
26				7½	8	8	8	10	10	10	12	12	12	13	13	13	15														26
28					8	8	10	10	10	12	12	13	13	15	15	15	17														28
					28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
30					10	10	12	12	13	13	15	15	17	17	19	20	20	22	22												30
32						12	13	13	15	17	17	19	19	20		22	23	23	25	25											32
34							13	15	17	19	20	22	22	23		23	25	25	27	27	28	28	30								34
36							15	17	19	20	22	23	23	25		27	27	28	28	28	30	32	32	34							36
38								19	20	22	23	25	27	27		28	28	30	32	32	34	34									38
40										40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
42										23	25	27	28	28		30	32	34	34	35	35	37	38	38	40	40					40
44											27	28	30	32		34	34	35	37	37	38	40	42	44	45	47	47	48	50	50	42
46												28	32	34		35	37	37	38	40	42	44	45	47	48	50	52	53	53	55	44
48													32	35		37	38	40	42	44	45	47	48	50	52	53	55	56	58	60	46
																	40	42	44	45	47	48	50	52	53	55	56	58	60	62	64	48
	12	14	16	18	20	22	24	26	28	30	32	34	36	38																	
10		2	2	2½	3																										10
12	2½	2½	2½	3	3	4	4																								12
14	2½	2½	3	3	4	4	5	5	5	5½	7	7	7																		14
16	3	3	3	4	4	5	5	5½	5½	7	7	7	7½	8																	16
18	3	3	3	4	5	5	7	7	7½	7½	7½	8	8	8																	18
																50	42	44	45	47	48	52	53	55	56	58	62	64	65	69	71	
																52			50	53	56	58	60	62	64	69	72	74	77	79	
																54				56	60	64	67	70	72	74	77	80	82	85	
																56					64	69	72	77	80	82	85	87	89	92	
																58					67	74	76	84	89	90	94	100	103	106	

Table 5.—Cyanogas dosage chart No. 2.—To be used with humidities under 60 per cent. only. Based on over and around measurements.

The above chart shows the dosage required for trees of various sizes when approximately 1 oz. to 90 cub. ft. is used. For coastal areas or where humidities are over 60 per cent., use chart No. 1.

Leakage occurs through the tents, but the loss is being partially restored by further generation of gas. If for example the concentration opposite the figure 2 is called the lethal concentration then it will be seen that the time this is maintained is very similar for both materials As yet there has been no opportunity of testing these two substances in Victoria, but in the near future it is hoped to undertake a test on similar lines to that described above.

Presence of Wind and Water.

Fumigation in windy weather is inadvisable as unsatisfactory kills usually result. Wind in excess of a velocity of 5 miles per hour causes a noticeable buffeting of the tents, and the bellows-like effect produced is thought to reduce the concentration of the gas by increasing the leakage through the tent. Frequently, wind will lift a small corner of the tent, and although this may pass unnoticed, it would, nevertheless, prejudice the results seriously. The buffeting of the tents influences the uniformity of the concentration also, while a steady wind, blowing on one side of the tent, may cause a lowering of the concentration in this region, and in addition, by pressing the tent against infested fruit and leaves, many insects do not receive a lethal dose.

Apart from the effect on the concentration of the gas, the difficulty of handling large, heavy sheets in a wind must be considered. In northern Victoria there usually is less wind at night than during the day, and this is one reason why night fumigation is favoured. In this region, the wind often dies down at sunset, and a calm night follows.

Water on the trees, either as dew or rain, affects the concentration of the gas, because this gas has a marked affinity for free water. Fumigation has been successful in the Goulburn Valley district after 21 points of rain, and while the trees and tents were still wet; but it is a risky procedure, and while damage may not occur to the tree, the scale kill may be unsatisfactory.

Porosity of the Tent—Leakage.

The rapid falls in concentrations of the gas illustrated in Fig. 8, are due, principally, to the leakage through the more or less porous canvas of the sheets. A certain amount of absorption by the sheet, the tree, and the soil also occurs, and assists in decreasing the concentrations.

The amount of leakage of gas from the tent, due to the porosity of the material, will depend upon the surface area of the sheet. This area will bear a more or less varying relationship with the volume. Simple calculations with cubes will reveal that a small cube will have a much larger surface-volume relationship than a large cube. For instance, a square tent with 2-ft. sides will have a volume of 8 cubic feet and a surface area—omitting the ground surface side—of 20 square feet, therefore there are 2·5 square feet for each cubic foot volume. Now compare this square tent with one having 9-ft. sides. The volume will be 729 cubic feet, and the superficial area—again omitting the one side which rests on the ground—will be only 405 square feet, and the relationship will be approximately 0.6 square feet for each cubic foot volume. In the two examples quoted, the loss from the smaller tent would be more than four times as great per cubic foot as that from the larger tent.

If the dosage was based on the cubic content alone, the small tree would receive a much lower mean concentration of gas, during the 45-minute period, due to the increased leakage. The shape of the covered tree resembles a tall dome, and therefore, the loss for small trees would be approximately three times as great per cubic foot as that for larger trees.

These differences are important, and Peters (2) has calculated that to achieve the same results of concentration for a small and a large tree, the dosages per cubic foot for the former would require to be at least four or five times as large

Table 6.—Rate of Dosages for Small and Large Trees.

Temperature more than 60° F. Relative Humidity more than 60 per cent.

Size of Tree. Height and Diameter.	Approximate Volume in Cubic Feet.	Cyanogas "A" Dust.		Calcid Briquettes.	
		Dosage. Ounces Dust.	Rate of Dosage.	Dosage. Number of Briquettes.	Rate of Dosage.
7 x 8 ..	317	4	1 oz. to 79 cubic feet	2½	1 gr. to 7 cubic feet
12 x 10 ..	848	8	1 oz. to 106 cubic feet	5	1 gr. to 8½ cubic feet
13 x 12 ..	1,324	13	1 oz. to 102 cubic feet	6	1 gr. to 11 cubic feet
14 x 15 ..	2,227	22	1 oz. to 101 cubic feet	11	1 gr. to 10 cubic feet

Fig. 9.—Citrus fruit and foliage infested with male and female scale.

as those for the latter. In actual practice, other circumstances influence the concentration, and this large difference is unnecessary. The approximate rate of dosage for several small and large trees is shown in Table 6. The minor fluctuations, noticed in this table, are due, no doubt, to the same dosage being recommended for trees within a range of sizes rather than to trees of a definite size.

The value of closely woven sheets will be appreciated when this loss of concentration by leakage is considered, and fumigators are advised only to purchase the heavy, closely woven material for fumigation.

When the material of the tents becomes damp it shrinks temporarily, thereby reducing its porosity. While in this state the concentration of gas can be maintained at a higher level, and for a longer time, than when the sheets have become extremely dry. Small increases of dosage are advisable when the sheets are in this dry condition, and will assist in compensating for the loss by leakage due to increase in porosity of the tent. On the other hand, care must be taken to see that no over-dosage is made when the tents are damp. Frequently, this will be associated with high humidities, and under such conditions, the experienced fumigator may reduce the dosage slightly—say 10 per cent—if he considers that damage may be caused to the trees. More frequently, however, he will prefer to work with sheets which have been tightened by dampness, because he realizes that excellent kills often are obtained under such conditions.

Wet sheets should not be used in fumigation, because they absorb large quantities of the gas, and may lead to injury of the fruit, as will be seen later.

Holes occur frequently in fumigation sheets, and a constant vigilance must be maintained to see that no damaged sheet is placed over a tree. Holes in that portion of the sheet covering the top of the tree are the most serious and the ones least likely to be detected. The light nature of the gas causes it to find an opening in this position very quickly, and the escape of gas can decrease rapidly the concentration within the tent. Small holes can be tied up temporarily, but, at the first opportunity, a patch of good material should be carefully sewn over the hole.

Tolerance of Citrus Trees for Hydrocyanic Acid Gas.

Whether a citrus tree can withstand a concentration of gas, sufficient to kill the scale, depends largely upon its condition and the circumstances accompanying the operation

Hydrocyanic acid gas, (HCN), affects both the respiration and assimilation; but the latter is affected to a greater extent than the former by lower concentrations of the gas. During daylight, and especially when the sun is shining brightly,

assimilation is particularly active, and therefore the effect of even low concentrations of gas may be detrimental to the tree, but not sufficiently high to result in an effective control of scale. This feature is puzzling to some fumigators, who often consider that the tree possesses some fixed degree of tolerance to the gas, whereas actually it is constantly varying with the changing physiological functions of the plant. At night, assimilation is at a minimum, and therefore fumigation is less dangerous to the plant, which, although it continues to breathe, can withstand relatively high concentrations of gas. The possibility of daylight fumigation, which will be considered shortly, depends largely upon an understanding of these facts.

Moore and Willaman (3), who have studied the effect of high concentrations of hydrocyanic acid gas on plant tissue, record that this gas is absorbed, and causes a reduction of the plant's respiratory activities; at the same time it increases the permeability of the leaf, thereby increasing water loss by transpiration. This loss of water is not replenished quickly enough, and the leaf wilts and may die subsequently. Lower concentrations of HCN, on the other hand, have a definite stimulating effect on plants for a brief period, and regular treatments of this gas have been utilized to "force" plants. This stimulation has been noticed frequently in citrus tree fumigation in Victoria. The sudden removal of a large population of scale insects, which have been depriving the tree of considerable amounts of elaborated food materials, would cause the tree to recover its vigor; but often, trees with comparatively few insects show this stimulation following a fumigation.

High temperatures, by stimulating the plant's activities, decrease its tolerance for HCN; but when these temperatures are associated with low humidities the tolerance appears to be increased. This may be explained by the closing of the stomata, or breathing pores, in the leaf surface under the influence of dry conditions.

Soft, sappy growth and very small, developing, green citrus fruits, may be expected to have a low tolerance for gaseous hydrocyanic acid, because, not only are the vital processes of such parts very active, but also the gas has a great affinity for the high water content of these parts.

Varietal susceptibility to HCN is another important aspect of tree tolerance. Various American workers, using the liquid HCN, have shown the lemon tree to possess the most tolerance for this gas, and then the order of tolerance is approximately — grapefruit, seedling oranges, mandarins, Valencia Late, navels, Homosassa, St. Michael and Mediterranean Sweet. In Victoria, a somewhat similar tolerance has been experienced with the liquid hydrocyanic acid, but with some calcium cyanide compounds, especially Cyanogas "A" dust, the lemon is more susceptible to injury. This injury, however, is not due to the concentration of the gas, but to the residue of dust remaining on the fruit and leaves.

The state of health of the trees also determines whether or not they will be susceptible to HCN. Weak and diseased trees possess a lower tolerance, while healthy trees grown under hard conditions, and trees on heavier soils, are more tolerant than trees growing in favoured situations or on light soils. It is difficult, sometimes, to estimate correctly the state of the vitality of the tree; but experience will enable the fumigator to form fairly correct opinions and to make suitable modifications in the operation.

Fumigation Injury.

A small amount of injury to plant tissue, due to the employment of toxic substances for the control of insect pests, is inseparable, at present, from routine orchard practice. In many cases the injury is not apparent, but nevertheless it may occur. With other treatments it is immediately noticeable. Fumigation injury usually can be classed with the latter group, although it sometimes remains invisible for seven or eight days. Any injury, which is not apparent within a fortnight of fumigation, should not be considered the result of this operation.

It must be realized that the use of such a toxic gas for the control of insect pests is, in itself, rather a phenomenal achievement in the world of pest control, and the wonder is that the amount of damage to the trees is so remarkably small. With more and more experience even this small amount of damage will be reduced, and fumigation then will be one of the most effective and safe means of controlling red scale.

Most of the fumigation damage which occurs at present could be avoided if the periods of fumigation were limited to those conditions which have been proved to be safe. For summer fumigation in Victoria, the atmospheric conditions which should be avoided are high temperatures and high humidities occurring simultaneously, especially when combined with sunlight. If the temperature is low and the humidity high, or vice versa, night fumigation, generally, will be safe.

WIDTH OF TREE (in feet)

HEIGHT OF TREE (in feet)	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	HEIGHT OF TREE (in feet)
4	1	1	1	1½	1½																		4
5		1	1	1½	2																		5
6		1	1½	1½	2	2½	2½	3	3½	4													6
7		1	1½	2	2	2½	3	3½	4	4½	5												7
8			1½	2	2½	2½	3	3½	4½	5	5½	5½	6	7									8
9				2	2½	3	3½	4	5	5½	5½	6	7	8	9								9
10					2½	3	3½	4½	5	5	6	7	8	9	10	11							10
11						3½	4	4½	5	6	7	8	9	10	11	12	13						11
12						3½	4	5	5	6	7	8	10	11	12	13	14	16	17	19	21	23	12
13								6	6	6	7	9	10	11	13	14	16	18	20	22	24	26	13
14								6	6	7	8	9	11	12	14	16	17	19	21	23	26	28	14
15									6	7	8	10	11	13	15	17	19	21	23	25	28	30	15
16									7	8	9	11	12	14	16	18	20	22	24	27	29	32	16
17										8	10	11	13	15	17	19	21	24	26	29	31	34	17
18										9	10	12	14	16	18	20	22	25	28	30	33	36	18
19										10	11	13	15	17	19	21	24	26	29	32	35	38	19
20										10	11	13	15	18	20	22	25	28	31	34	37	40	20
21													16	19	21	24	26	29	32	35	39	42	21
22													17	19	22	25	28	31	34	37	41	44	22
23													18	20	23	26	29	32	35	39	43	46	23
24													19	21	24	27	30	33	37	41	44	48	24
25														22	25	28	31	35	38	42	46	50	25
26														23	26	29	33	36	40	44	48	52	26
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

WIDTH OF TREE (in feet)

Table 7.—Calcid Briquette "Height and Diameter" dosage chart. Dosage given in number of briquettes. Time of exposure, 40 minutes.

Dosages calculated for general Australian conditions, using not less than 10-oz. Duck sheets. Increase the above dosages by 10 per cent. if temperature is below 60° F. This chart is based on approximately one briquette per 200 cub. ft. of space.

The temperatures and relative humidities which have been found safe for fumigation in Northern Victoria are :—

Temperature.	*Relative Humidity.*
80° to 90° F.	Below 40 per cent.
75° to 79° F.	,, 60 ,,
70° to 74° F.	,, 82 ,,
60° to 69° F.	,, 90 ,,
50° to 59° F.	,, 94 ,,

It is recommended, however, that fumigation should be discontinued above a relative humidity of 85 per cent. unless performed under the direction of a very experienced fumigator, who can estimate the tolerance of the particular trees being fumigated.

In the section on tree tolerance, mention has been made of other factors which will determine whether tree injury will result from fumigation. The effect of a heavy rainfall or an irrigation a few days prior to fumigation was not considered, but it is very important. The immediate effect of the wet soil is to increase the humidity under the tent, but there is another effect, which is not so easily recorded, and that is the stimulation of growth in the tree and a quickening of its normal functions. The tree's growth has become more active, and therefore renders itself liable to injury by concentrations of gas, which it could tolerate when in a less active condition. Irrigation should be applied at least two weeks before fumigation.

Fumigation injury may occur in many forms. "Tip-burn," as the name implies, results in the blackening of the young tender growing tips, and usually is regarded as a good indication that the dosage has been satisfactory. Often, accompanying "tip-burn," is a small leaf fall, usually of old leaves, which would fall naturally within a few weeks, but fumigation has hastened their abscission.

"Leaf-fall" or defoliation of a more serious nature will include the mature leaves, and may be partial or complete, according to the concentration of gas or the subsequent conditions, such as a sudden marked fall in temperature, which often causes injury to recently fumigated trees. Woglum (4) has shown that trees fumigated in diffused light were defoliated when exposed later to bright sunlight. This condition, however, is not met with in practice in Victoria.

When the defoliation is serious, often the fruit will be pitted or scorched. Small, depressed brown areas will develop in a few days, or sometimes the fruit appears as if it had been toasted slightly.

Another form of injury, which was fairly prevalent before the present refined nozzles were adopted, was the defoliation and scorching of fruit in one particular portion of the tree, resulting in a chimney-like effect through the foliage. This was caused by the severe concentrations of gas in the blast of dust as it left the mouth of the delivery pipe. Modifications of the nozzles have eliminated this form of injury, and the gas is delivered now in a flat cloud over the soil surface and then filters up through the tree.

When fumigation injury is severe the leaves wilt and shrivel up, as if they had been scorched by fire; but when injury is slight, apparently green, healthy leaves are found under the trees. Injury of the former type may be accompanied by the death of small twigs. If this is the case the best treatment is to prune out all these dead twigs and immediately apply an irrigation. Fumigated trees have immense recuperative powers and recover quickly if immediate treatment is given.

Mention has been made previously of the injury under certain conditions, due to the residue of Cyanogas "A" dust, particularly on lemons. High humidities, or light rain, following fumigation often cause a scorch on the upper surface of the fruit beneath the dust residue. The high salt

(NaCl) and quicklime (CaO) content of Cyanogas "A" dust appears to be responsible for this injury. Both these substances absorb moisture readily, and the resulting saturated solution causes a withdrawal of moisture from the superficial cells of the fruit, bringing about their collapse and ultimate death. In January and February, fumigation of lemons with this dust is safe, except for the occurrence of a light shower of rain immediately after fumigation. Later in the season, when the humidity generally exceeds 45 to 50 per cent., it is advisable to use Cyanogas "G" fumigant rather than the "A" dust.

Mortality of Scale.

Successful results from fumigation are measured in terms of the percentage mortality of scale. Whether these results vary between 95 and 99 per cent. depends largely upon the skill of the fumigator, and the circumstances surrounding the operation. While 100 per cent. kills have been obtained frequently, it cannot be claimed for this, or any other method of control, that such results can be expected always.

The determination of the kill, solely due to fumigation, is not an easy task, because the natural mortality of the scale will influence the results. A period of about two weeks must elapse before determinations can be made, and during this time many scales, which may have survived the fumigation, will die naturally. In most calculations of this nature, the percentage kill, due to fumigation, also includes the natural mortality; but in careful experiments it would be advisable to make provision for the estimation of these natural deaths.

After successful fumigation the scales darken in colour, and while this is often an indication of success, only careful observation, with a lens, of the actual drying up of the body of the insect in a week or a fortnight, should be regarded as definite evidence of death.

Many growers estimate the success or otherwise of a fumigation by the number of live scale they can find in their grove. While it is recognized that if several live scale are found, the grower naturally will be disappointed, he must not condemn fumigation for this reason alone. The initial population of scale may have

DISTANCE AROUND TREE IN FEET.

DISTANCE OVER TREE IN FEET.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	DISTANCE OVER TREE IN FEET.
6	½	½	½	½	½	½	½	1																										6
8	½	½	½	½	½	1	1	1																										8
10		1	1	1	1	1	1	1½																										10
12				1	1	1	1½	1½	2	2	2½	2½	2½	3																				12
14				1	1	1½	1½	2	2	2½	2½	2½	3	3	3	3																		14
16					1½	1½	2	2	2½	2½	3	3	3	3½	3½	3½	4	4																16
18						2	2	2½	2½	3	3	3½	3½	3½	3½	4	4	4½																18
20							2	2½	3	3	3½	3½	3½	3½	4	4	4½	4½																20
22								3½	3½	3½	4	4	4	4	4	4½	4½	5	5	5	5												22
24								3½	3½	4	4	4	4	4	4½	4½	5	5	5	6	6	6											24
26									4	4	4	4	4	4½	4½	5	5	6	6	6	7	7	8										26
28										4	4	4½	4½	5	5	6	6	7	7	8	8	9											28
30												4½	4½	5	5	6	6	7	7	8	8	9	9										30
32														6	6	7	7	8	8	9	9	10	10	11	11	12	12	13					32
34															7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15				34
36																8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16			36
38																	9	10	11	11	12	12	13	13	13	14	14	15	15	16	16	17		38
40																		11	11	12	12	13	13	13	14	14	15	15	16	16	17	17	18	40
42																			12	13	13	14	14	14	15	15	16	16	17	17	18	18	19	42
44																				13	14	14	15	15	15	16	16	16	17	17	18	19	20	44
46																					14	15	15	16	16	17	17	17	18	19	19	20	21	46
48																						15	16	16	17	17	18	18	19	19	20	21	22	48
50																							16	17	17	18	18	19	20	20	21	22	23	50
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	

Citrus Tree Fumigation with Calcid Briquettes. Dosage given in number of Briquettes.

DISTANCE AROUND TREE IN FEET.

Table 8.—Calcid Briquette "Over and Around" dosage chart for temperatures of 70° to 82° F.

Dosages calculated for general Australian conditions, using good 10-oz. Duck covers. For temperatures ranging from 60° to 70° F. increase these dosages by 10 per cent., and for temperatures under 60° F. increase by 25 per cent. Scale insects are more resistant to the action of HCN gas in cold weather, hence the increased dosages for lower temperatures. This chart is based on approximately one briquette per 200 cub. ft.

TABLE 9.—APPROXIMATE COST OF FUMIGATION SHEETS (OCTAGON SHAPE).

Size.	British Calico.	Heavy Tent. Cotton Duck.	10½-oz. British Super Cotton Duck.	Super British Grey. Calico.	12½-oz. British Pure Cotton Duck.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*
18 x 18	26 4	35 8	50 0	54 0	59 0
24 x 24	45 0	62 6	89 0	98 0	106 0
30 x 30	66 4	93 2	133 0	147 0	160 0
36 x 36	90 0	127 6	184 0	203 0	221 0
42 x 42	..	176 2	253 0	279 0	305 0
45 x 45	..	203 0	292 0	322 0	352 0
56 x 56	..	303 6	437 0	482 0	526 0

Sheets branded with capacity measurements.

These prices are less 2½ per cent. cash discount, plus 5 per cent. sales tax.

been extremely heavy and the fumigation may have killed 99·9 per cent. of them, and only 0·1 per cent., of perhaps many millions, remain alive on the trees. This 0·1 per cent. would represent a large number of scales, but the fumigation could not be regarded as unsuccessful. The effectiveness of a fumigation in controlling scale depends largely upon the extent of the infestation as well as upon the percentage mortality.

Much has been said regarding the concentration of gas which is toxic to the scale. Recent experiments by Moore (5) have shown that, although different dosages, different materials, and different methods of application have been employed, the time in minutes multiplied by the mean concentration of the gas, expressed as percentage HCN by volume, has varied but little. This constant is in the region of 3·4.

In the past, many workers have considered that during the second moult and the early grey adult stages in development, the scale was more or less immune to the gas, on account of its very dormant nature at this time. Moore (5), however, has found that the proportion of scales in these stages did not determine the effectiveness of the fumigation; but probably will determine which insects survive in an unsuccessful fumigation.

Two other phases of this problem must be considered in this section, viz., "resistant" scale and protective stupefaction. The former is not of much importance to Victorian citrus-growers, because no "resistant" strains of red scale have been located. It is interesting, however, to quote Moore (5) in this respect. He states—

> "That under unfavorable conditions the kill of 'resistant' red scale is decidedly reduced, whereas the kill of 'non-resistant' red scale is influenced but slightly. Under favorable conditions, there is no significant difference between the kills of 'resistant' and 'non-resistant' red scale. The main difference between 'resistant' and 'non-resistant' red scale is the influence, upon the result of fumigation, of certain environmental conditions."

Protective stupefaction is the name given to the condition of scales, observed by Gray and Kirkpatrick (6), who found that a preliminary exposure of red scale to low concentrations of gas rendered them difficult to kill by increased concentrations immediately afterwards. This condition was thought to be brought about in two ways—(1) by drift gas from leaky tents nearby, and (2) the exposure of insects to sub-lethal concentrations due to faulty distribution within the tent. This preliminary exposure acts as an anaesthetic, and the scale is supposed to sleep through the fumigation period. Other workers have confirmed this discovery; but as yet, Victorian experience of fumigation has revealed no evidence of this condition. Moore (5) found recently that, exposure to low concentrations, preceding the regular fumigation, does not always reduce the kill.

Daylight Fumigation.

Fumigation in daylight seldom is practised in Victoria. Many small successful trials have been carried out, but the practice has not been standardized to any extent. It is felt that during a long dry autumn and even during the winter, there is much opportunity for daylight work, but conditions do not appear to be favorable during the summer months. This phase of the work requires more research before definite recommendations can be made.

Bordeaux Mixture and Fumigation.

Very disastrous results frequently occur when fumigation follows too soon upon a Bordeaux spray, or after the trunks of the citrus trees have been painted with Bordeaux paste. Various authorities state that periods of from six to ten months should elapse before such trees are fumigated. Butler and Jenkins (7) found that the formation of cupric cyanide — the harmful

compound—was determined by the ratio of copper sulphate to quick-lime used in making the mixture. A neutral or approximately neutral Bordeaux mixture was the only type that could be recommended with safety when sprayed plants were to be subjected to fumigation by hydrocyanic acid gas.

Combination Treatment.

Combined treatments of white oil emulsion sprays, followed in a week or two by fumigation, is a practice frequently recommended in California. Victorian growers, who have heavy infestations of red scale on their trees, would find such a treatment very effective. Such intense measures would reduce the scale infestation to such an extent that the grower could combat the pest with less drastic treatment.

One of the advantages of such a programme is that the small percentage of live scale, usually on the fruit, which may survive a fumigation, is reduced by the preliminary oil spray.

Careful Records Essential.

In all fumigation work the keeping of careful records is essential. Not only must the ordinary data of the grove, number of trees, method used, dosage, &c., be recorded, but careful notes also should be kept of the weather conditions immediately prior to, during, and immediately after fumigation. The state of the trees should be noted, and in this regard the density of the foliage the "skirting" around the base of the tree, their health and vigor and their condition, in respect to water supply, are all important points.

The estimation of the scale infestation is also another useful observation, and groves could be grouped under, say, five headings as "very heavy," "heavy," "fair," &c. The varieties of trees and any other conditions which may have a bearing on the success of the operation should be recorded.

Inspections made subsequently to fumigation are extremely useful. The records of these observations should be preserved for further use, and they will prove of great value when the grove has to be refumigated. Whether or not such an operation will be required within a period of two or three years will depend of course upon the percentage kill obtained in relation to the initial infestation, and also, upon the facilities for re-infestation from surrounding trees.

White Oil Emulsion Sprays.

While the object of this article is to deal, primarily, with the control of red scale by fumigation, it is considered desirable to draw the attention of growers to the main points to be observed in controlling this pest by spraying with white oils.

In Victoria it cannot be overlooked that many growers have retained control of the red scale problem, solely by the use of white oil sprays. To achieve this control, constant and thorough spraying must be adopted. If the infestation becomes very heavy, then it is problematical whether control by spraying is economical. It appears from recent tests in this State that two oil sprays should be applied; one during January or February, and the other in April or early May.

As oil spraying, to be effective, depends on contact between the oil film and the scale insect, the necessity for thoroughness will be appreciated.

Further Considerations.

There is an urgent need for those growers, who are unfortunate enough to have red scale in their groves, to adopt some concerted action in an endeavour to reduce the infestation. Certain officers of the Department of Agriculture have been given the power, under the Vegetation and Vine Diseases Act, to compel growers to adopt effective measures of control against this, and many other, proclaimed insect pests. Fruit infested with red scale is not permitted to be sold.

There should be no necessity to compel growers to help themselves, and if district organizations could foster concerted action, even among small groups of growers whose groves are adjacent to one another, then red scale would become a less serious menace than it is to-day. The obstinate grower, with an infested grove, especially when adjacent to other groves commercially clean could be suitably dealt with.

Literature Cited.

1. Quayle, H. J. Hilgardia 3 (8), 213–214. April, 1928.
2. Peters, G. A Short Guide to Tree Fumigation, 2nd Ed. 1934.
3. Moore, W., and Willaman, J. J. Jour. Agr. Res. 11. 319. 1917.
4. Woglum, R. S. U.S.A. Dept. of Agr. Bull. No. 907, 1920.
5. Moore, W. Jour. Econ. Entom. 26 (6). Dec. 1933.
6. Gray, G. P., and Kirkpatrick, A. F. Jour. Econ. Entom. 22 (6) 878–892.
7. Butler, O., and Jenkins, R. R. Phytopath. 20 (5). 419–429, 1930.

Prevention of Frost Damage

Heating in Orchards

By E. E. Pescott, F.L.S., Senior Horticultural Instructor, and D. D. Brown, Orchard Superviser

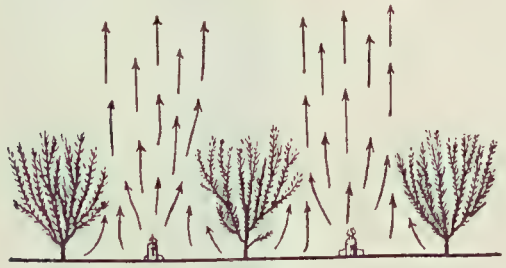
THE prevention of frost damage to orchard trees and fruit has long passed the experimental stage; in some countries guarding against harm by raising the temperature of the orchard air during the immediate danger period is regarded as part of the ordinary routine. The important point is whether the expense of the work comes under the heading of practical orchard economics.

This season, at Quantong, a grower lost practically his whole crop of apricots, an estimated loss of £300. A few years ago an orchardist in the Castlemaine district lost his whole crop of plums, which had already been sold to a jam factory for £400. It does not require much argument to show that any reasonable expense incurred in saving the whole, or perhaps only a fair portion of these crops, would have been sound economically.

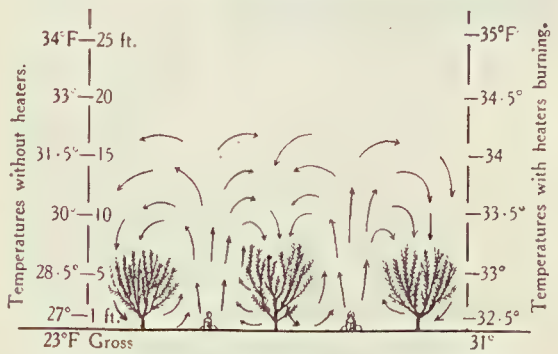
The danger to fruit crops is almost entirely confined to the spring period, when the growing fruit is quite tender and the stone fruits have not yet "stoned." Frosts are liable to occur even as late as mid-November.

Dangerous Temperatures.

The following data have been supplied by the Commonwealth Meteorological Bureau, Melbourne, and show the degree of cold which will probably be endured by different fruits up to 30 minutes without damage:—



No Temperature Inversion—Heat goes straight upwards.



Good Temperature Inversion—Heat deflected downwards by warm air higher up.

Fruit.	Stage of Development.		
	Buds Closed but Showing Colour.	Full Bloom.	Small Green Fruits.
	°F.	°F.	°F.
Apples	27	29	30
Apricots	30	31	32
Almonds	28	30	31
Blackberries ..	28	28	28
Cherries	25	28	30
Grapes	31	32	32
Lemons	..	32	30
Oranges	30	30	..
Pears	28	29	30
Peaches	25	28	30
Plums	30	31	31
Prunes	30	31	31
Raspberries ..	28	28	28
Strawberries ..	28	28	28

Methods of Prevention.

There are two methods in common practice for the protection of trees. The first is the use of smudge or smoke fires or screens, by which the

orchard area is enveloped with smoke. The older methods of creating smoke included the burning of wood, bark, or any forest waste, perhaps combined with tar, resin, pitch, or other material calculated to produce a dense pall of smoke. In this way radiation from the surface of the ground was prevented.

In France, the modern method of using military smoke screens as smudges is now in common operation, the smoke being released from steel cylinders. The smoke can be produced in two ways; one generates the cloud by the action of gaseous ammonia on chlorosulphonic acid; the other obtains it from the inter-action of gaseous ammonia and sulphur dioxide, released from steel cylinders, which combine in a special apparatus before being liberated. The reaction gives off much heat, and dense clouds of glowing vapours rise fairly high into the air. As cooling takes place, the cloud forms a regular fog bank and covers the ground to a height of 35 to 50 feet.

The cost of ingredients in France for a single frost is under 300 francs (about £3) for each machine. One machine can effectively protect an area of from 12 to 25 acres.

Orchard Heating.

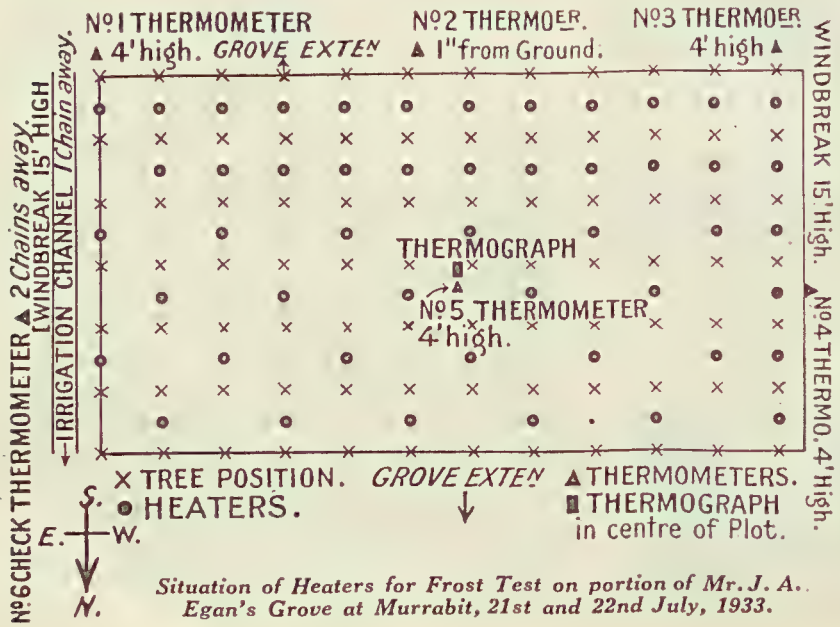
Owing to the lack of forest material for smudge fires, orchardists have adopted the method of direct heating for the protection of their trees and vines. By burning oil, coal, coke, briquettes, or any other type of fuel, in specially made containers, heat is imparted to the surrounding air, and the orchard temperatures are quickly raised. The success of this practice depends on whether temperature inversion is present; that is whether the air at the higher levels is slightly warmer than that at ground level. If this be the case, then the heated air will reach a level correlating to its own temperature. Having reached this level it spreads laterally in all directions, thus creating a warm pall. The temperature quickly increases at the lower levels, and the whole of the orchard air becomes heated to such a degree that the frost temperature is kept out, and the trees are protected. A glance at the illustration on the preceding page will illustrate this.

Temperature inversion is readily checked or recorded by mounting one thermometer a foot from the ground, and a second 25 feet from the ground. These thermometers should be placed away from tall trees and buildings, and be well exposed among the orchard trees.

Warning of Frosts.

It is necessary that orchardists receive a definite warning of the likelihood of frost, and not depend upon their own feelings and opinion. To attain this end, alarm thermometers are placed where they will register the orchard temperature.

In alarm thermometers a platinum wire is set into the glass tube from which it is connected with the wire terminals. As soon as the mercury touches the platinum wire, an electrical contact is made. The thermometer being connected by wire with an electric battery and bell, the bell rings at once. It is usual to place the bell in the orchardist's bedroom, so that if a frost occurs in the early hours he may be roused.



Situation of Heaters for Frost Test on portion of Mr. J. A. Egan's Grove at Murrabit, 21st and 22nd July, 1933.

Tests at Murrabit.

On the 21st and 22nd July of this year tests of the value of frost prevention were carried out in the mandarin grove of Mr. J. A. Egan at Murrabit. A section was selected in the middle of the grove; there were seven trees on the sides running north and south, while each of the other sides was bounded by twelve trees. The area, slightly more than an acre, was particularly flat, with

a wattle tree shelter growth, 15 feet high, on the west side, about 20 feet away from the nearest row of trees, and a similar shelter on the east side, about 2 chains from the nearest trees. Running between this last-mentioned shelter break and the first row of mandarins, was an irrigation channel about 15 feet wide. No shelter of any kind, excepting that of the remaining portion of the groove, existed on the north or south sides.

Soil Condition.—The condition of the soil was good; it had an average moisture content, the last irrigation having been applied at the beginning of April; this had been followed by a cultivation. Owing to the dry winter no cover crop had been sown, and practically no weed growth had taken place.

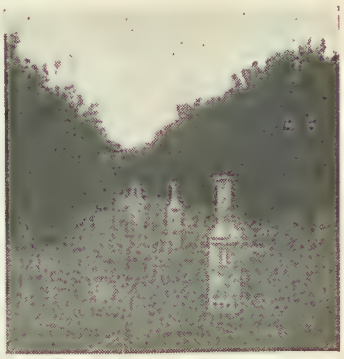
Heaters.—Forty-nine heaters were used. One was placed at each tree on the first two rows at the southern side, and one at each tree in the first row on the west side, and one at each alternate tree throughout the remainder of the 84 trees in the test plot. This is indicated in the chart shown on page 18.

Fuel.—Twenty-five lb. of briquettes was used by each burner, at a cost of 4½d. per burner.

Firing and Control.—Firing was started at 1.12 a.m. by lighting the south-east burner; then working west along that row, and east on the next, &c., all burners were lit by 1.25. Dense smoke was formed from then till 2 a.m., and by 2.45 a.m. all heaters were burning exceedingly well, and were red hot. This smoke screen was created by pushing down the dampers on the top of the chimney ten minutes after firing, to reserve the fuel for the colder hours of the morning. Extra heat, as shown in the thermometer readings, was obtained by raising the two slots—one on each side of the burner—thus creating greater draught.

Type of briquette heater used at Murrabit.

Thermometers and Placements.—Six thermometers were used, and were placed as follows:—(1) South-east corner on the first tree of row, immediately south of experimental plot, 4 feet from the ground, and 30 feet from the nearest burner. (2) Near tree in middle of same row, 1 inch from ground, and same distance from nearest burner. (3) On last tree of same row, in south-west portion, 4 feet high, and same distance from burners. (4) On west side, on small wattle tree, 4 feet from ground, and 30 feet from nearest burner. *Note.*—At 2.45 a.m., owing to a change of wind drift from south to east, it became necessary, in order to catch the warm current of air, to transfer this thermometer from the north side to the west. (5) In exact centre of plot, 4 feet from ground, and adjoining thermograph. (6) On fence post, in exposed position, 4 feet high, behind east shelter trees, and about 2 chains from nearest mandarin tree. All thermometers were in well exposed positions.



Briquette heaters in Citrus Grove at Murrabit.

Thermometer Readings.—Thermometer readings were taken at different times and were as follow:—

—	Thermometers.						Thermo-graph.
	1.	2 (1″ high).	3.	4.	5.	6 (check).	
1 a.m., before test ..	30	29	30	30	29·2	29	29·2
2 a.m., ½ hour after filling ..	31	28½	31	32	31	30	30
2.45 a.m. ..	31½	28	32	33	34	28½	31·5
3.15 a.m. ..	31	28	31	32½	34	28	33·5
3.30 a.m., extra heat.							
4 a.m. ..	30	27	31	34	35	27	35
4.45 a.m. ..	31	30	31	34·5	35	28	35
5.30 a.m. ..	32	31·5	32	35	35	30·5	34·7
6.10, heaters out ..	32·5	32	31·5	36	34·5	31	34
6.30 a.m. ..	32	32	31	34	33·5	31	32

Weather Conditions.—The night was very still with at first a faint south drift, which changed at 2 a.m. to a faint south-east drift, followed at 2.30 a.m. by a slight haze. At 3 a.m. conditions were quite clear, with a drift still from south-east. At 4.30 a.m. conditions were very still, and smoke from the only oil burner was rising perpendicularly; a slight fog was falling. At 5.30 a distinct drift from the south-east was

experienced, followed by a very slight breeze from the same direction, which gradually raised the mercury, until at 6.30 a.m. the outside temperature had perceptibly risen. It will be noted that at 4 a.m., when the extra heat by opening the air vents at the sides of burners was given, while the temperature on thermometer No. 2 1 inch from the ground on the exposed side, and on check thermometer No. 6, had fallen from 28° to 27°, the temperatures on thermometers Nos. 4 and 5, which were most influenced by the burners, had risen from 32.5° to 34°, and from 34° to 35° respectively.

Readings during evening before test.—

5.30 p.m.	.. ..	52°
6.0 ,,	.. ..	47°
7.30 ,,	.. ..	43°
10.0 ,,	.. ..	36°
10.45 ,,	.. ..	34°
11.30 ,,	.. ..	32°

Cleaning of heaters.—All heaters were cleaned out during the day on which the test was taken, and less than half a bucket of ashes was obtained from the lot.

The heaters were again filled with briquettes in preparation for a possible frost on the following night; but after waiting until 3.30 a.m., a slight breeze arose from the south-east, accompanied by light clouds, the mercury rising from a minimum of 32° to 35°. The tests were then abandoned.

The heaters used are simple in construction, but possess several distinctive features. They consist of two parts—the cylinder with grate which contains the fuel, and a top part which fits into the cylinder, comprising a draught cone, stack, and damper. For storage purposes the top portion can be disconnected and placed in the cylinder. The heater will burn any solid fuel such as briquettes, coke, charcoal, or coal, but for fuels other than briquettes a special grate is necessary. The brown coal briquettes burn to a very fine ash, and require a grate with smaller spaces between the bars than would be used for the other fuels. To secure the maximum amount of burning from coke, charcoal, or coal, it is essential to clean the grate towards the latter part of the burning, and for this purpose a patent "raker" grate is provided.

The cylinder previously mentioned has two slots, one on either side, with sliding doors. These slots are operated only when it is necessary to obtain a maximum heat as soon as possible. Otherwise the draught and rate of burning are controlled by raising or lowering the dampers on the top of the stack. The cylinder will hold 25 lb. of brown coal briquettes, sufficient for five hours burning at a maximum rate. By controlling the rate of burning, the necessity for which would depend on the severity of the frost, the time can be increased to six or seven hours. This, in normal conditions, would be ample for any but the most severe frosts. If a further period be required, it would be an easy matter to refuel with a few pounds more from convenient supplies, either by dropping the fuel through the stack, or by lifting off the top portion of the heater. Special asbestos gloves must be worn when lifting the lid.

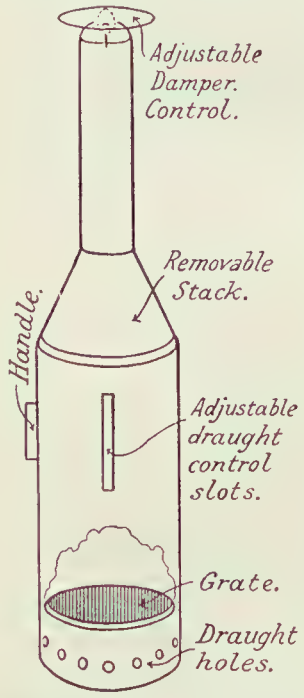


Diagram of Briquette or Solid Fuel Orchard Heater.

For lighting purposes a few kindlers are placed on top of the briquettes, the cone and stack of the heater being lifted off and the kindlers ignited by means of a kerosene torch *from the top*. For any other solid fuels, it has been found more satisfactory to ignite about 6 inches from the top. For this purpose special kindlers are made, and placed opposite the slots in the side of the cylinders, and the torch applied to them. These special kindlers are very efficient, especially for lighting coke, and they are inexpensive. No trouble is experienced in the actual lighting of any fuel, and the heater generates considerable heat in from 15 to 20 minutes. The method of control of burning merely consists of raising or lowering the dampers on top of the stack, which operate inside by means of spring standards.

Brown coal briquettes prove a very satisfactory type of fuel, owing to their standard size and quality, as well as their low cost. They are also easy and convenient to handle. Assuming 30s. per ton to be an average price for towns up to 150 miles from Melbourne, the cost per heater for a full night's burning would be 4d.; at 35s., 4.68d., and at 40s., 5.35d. per burner.

Where briquettes are not available, coke and charcoal are excellent fuels; the heaters hold approximately 20 lb. of each.

The heaters are constructed of 24-in. gauge iron throughout, except the handles and other fittings, which are made of a heavier metal. The period for which they could be used would naturally depend on the treatment and care accorded. Two hundred or more hours of burning should be obtained without difficulty, provided reasonable care be taken.

To protect the heaters before stacking them away after the season's operations, they should be dipped in a bath of tar or some other rust preventative.

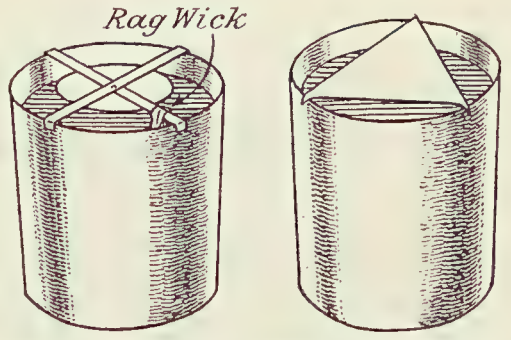
The Harcourt Experiments.

Experiments were carried out at Harcourt by one of the oil companies, and were kept under official observation. The work was done in the orchard of Mr. William Eagle, and oil burners were used exclusively.

Various types of heaters were at first tested, notably one of the "drip feed" type. Oil from the container is fed steadily into a combustion tray through a pipe with an adjustable valve. The rate of burning can be very easily regulated, and the heaters were very effective, but the capital cost—over 10s. each—was prohibitive.

Apart from this, the danger of rain water collecting in the combustion dish, as well as the slowness of lighting, are militating factors against the use of this type of burner.

Bucket heaters were next tried, and all kinds were used with unqualified success. As well as being a success from a burning stand-point, they may be readily and compactly stored for the next period of firing.



Circular Damper. *Triangular Damper.*

Bucket Heaters for Oil Burning.

The types illustrated were very satisfactory. Equally useful burners may be made from the 2-gallon oil or paint drums obtainable from hardware establishments.

Dampers should be made to fit over the top of the burner, so that excessive burning may not take place. The wick, which can be made from any old rag or cloth, may be hung on to the damper. Lids should be provided, so that when the temperature has been raised above danger point, and there is no immediate fear from frost, the heaters may be quickly extinguished and fuel saved. At Harcourt 50 burners per acre were used, and a low grade of oil burned.

The heaters must be protected from water drip; therefore when the frost period arrives and they are set out in the orchard, the covering lid must be used; this can be readily thrown aside when the machine is being lit and the rag burner lighted with a kerosene or petrol flame-thrower, such as a painter's blow lamp.

An estimate of the cost of the Harcourt experiments shows that, allowing the life of the heaters to extend from five to seven years, and reckoning this in with the cost of oil, the amount expended would average about 2s. per tree.

Assuming that a tree would produce five bushels at a value of from twenty shillings upwards, it is certainly reasonable to recommend an expenditure of two or three shillings to save the crop from possible total destruction by frost.

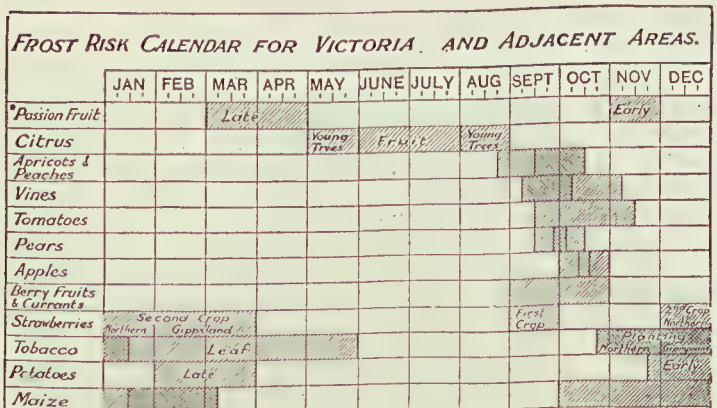


Fig. 3.

A New Publication.

A publication entitled "Frost Risks and Frost Forecasting" has

been issued recently by the Commonwealth Bureau of Meteorology. The subjects in the pamphlet include, Frost Risks, Recurrence of Frosts, Preventive Measures, Methods of Heating, Crops Affected, Critical Temperatures for Fruit, Local Frost Forecasting, and Weather Bureau Frost Warnings.

It is important to note that there are certain danger spots; one is the meeting point of two valleys where there is a barrier to the line of cold air drift; others are such places as channel banks, level ground at the foot of a slope where the drift ceases to move, and natural hollows from which the air does not flow away.

Conditions favouring frost are clear still nights, usually but not always following fine dry days; low humidity; and quiet conditions permitting the settling of the cold dense air.

During danger periods, frost warnings are broadcast by the National Broadcasting Stations, chiefly from 3LO, 3AR, and 2CO. Warnings are usually issued between 4 and 5 p.m.; again between 6 and 7 p.m.; and once again with the late weather forecast.

The final note in the booklet contains advice which every prospective orchardist should heed: "Frost Prevention in its earliest stages lies in the choice of a site."

Smudge Fires in Use at Dookie.

Dried Blood and Meat Meal

DRIED blood is used in feeding as a protein concentrate, being added to a mixed ration to build up the protein content and thus effect a satisfactory nutritive ratio. Meat meals are used in a similar manner, and are probably more popular here than blood meal. Both blood and meat meals, when sold for feeding purposes, are sterilized, and thus may be safely used with stock. With blood meal, however, it is essential that the material should be in a finely-ground condition, as the granular form causes digestive troubles.

Either blood or meat meal could be used in a ration for pigs and fowls, but meat meal is, perhaps, preferable. The amount used is governed by the composition of the ration fed to the stock, varying with the protein contents of the other ingredients. Probably 10 lb. in 100 lb. of mixed ration would be the maximum, and would be fed to pigs at eight to ten weeks old. As the pigs grow older the amount is reduced gradually so that 7 lb. to 100 lb. of mixed ration would be fed at five months. Owing to its highly protein nature meat meal is particularly useful for feeding to pigs together with such protein deficient foodstuffs as potatoes, whey, and to a lesser extent, barley and the other cereal grains. Blood and meat meals can be obtained from most suppliers of dairy feeds or direct from the manufacturers.

Insect Control

The Part of Insecticides

By R. T. M. Pescott, M.Agr.Sc., Entomologist.

THE conception of a "struggle for existence" among living organisms has, as a natural corollary, the idea of a "natural balance." If we consider an individual plant, the continuation of the species will depend upon its ability to attain maturity and provide for the reproduction of its kind despite the many factors which tend towards the suppression of that plant. Of these factors, one of the most important groups comprise those organisms—the insect pests of the plant—which in the course of their existence cause direct injury or prejudice its successful development. If the plant tends towards an increase, conditions will favour the multiplication of these insects, the increase of the insects bringing about, in turn, a reduction of the productivity of the plant. These processes result in the establishment of an equilibrium—the "natural balance."

Man is able to modify this natural balance to better suit his own needs. He is able to encourage artificially the growth and reproduction of those plants useful to him as crop and orchard plants, and to discourage the growth and reproduction of those particular insects which because of that encouragement, tend likewise to increase. It is because of this tendency to increase that there arises the need for methods of plant protection.

Any attempt to classify, under definite headings, the various methods now employed in plant protection is rendered difficult, not so much by their complexity as by their interdependence one upon the other. By adopting groups sufficiently wide, it is convenient to summarize these methods in the following manner:—

A.—Preventive Measures.

In which groups may be included those measures concerning more directly—

1. *The Host Plant*:
   - (*a*) The use of resistant varieties.
   - (*b*) Methods employing the influence of external factors on the susceptibility and liability of the plant to attack.
   - (*c*) Methods by which the plant is covered with a chemical capable of protecting it from attack or of deterring its insect pests.
2. *The Parasite*:
   - (*a*) The destruction of the parasite either—
     - (i) on the seed } prior to
     - (ii) in the soil } planting.
   - (*b*) The encouragement of the enemies of the parasite, i.e., biological control.
   - (*c*) Mechanical means whereby the parasite is trapped or infection is prevented.
   - (*d*) The treatment of centres and carriers of infection.

B.—Curative Measures.

These consist of the destruction of the parasite by the application of toxic chemicals, once the plant is definitely attacked by these parasites.

Of the above groups A. 1 (*c*) and B. are the two with which we are concerned in this discussion on insecticides.

Briefly, there are two methods by which an insect obtains its food from plants; these methods depend entirely on the construction of the mouth parts of the insects concerned. This fact is of the greatest importance in insect control by means of insecticides as it is a means for determining which type of insecticide is most applicable in the case in question.

Firstly there are those insects possessing horny jaws, which, by working side by side, actually chew portions of the plant tissue; these are spoken of as chewing or mandibulate insects,

and to this class belong such insects as grasshoppers, beetles, and caterpillars. Secondly, there are those insects in which the mouth parts are modified to form long thread-like organs by means of which the insect pierces the outer surface of the plant tissues and derives its nourishment by sucking the liquid cell contents. These insects are spoken of as sucking or suctorial insects, and to this class belong such pests as aphides, thrips, plant bugs, and scales.

Against the first type of insect, i.e., the chewing insect, the insecticide used is generally called a "stomach poison." This, when eaten together with the plant tissue, kills the insect by absorption through the alimentary system. With the sucking type of insect, however, such an insecticide would fail to reach the stomach and it is necessary to use an insecticide spoken of as a "contact poison" killing the insect by contact with and probably absorption by the body walls. In this group, too, usually are placed those materials used to kill or inhibit the hatching of the insect egg, such materials usually being called "ovicides." The insect may, however, be killed by an absorption of the poison through the respiratory system, gassed as it were, by a volatile chemical, spoken of as a "fumigant." Finally, there are those substances, "deterrents," the presence of which render the plant distasteful to the insect.

This classification of insecticides is quite arbitrary, and in some cases, a certain chemical will appear under more than one of the above headings. For example, nicotine, which is usually classed with the contact poisons, may act in some cases as a stomach poison, it may be used as a fumigant, or its presence may reduce insect attack by a deterrent action. Among other examples of this may be quoted lime sulphur and Rotenone which act both as contact insecticides and stomach poisons. Moreover, it is quite possible that many of the present day insecticides may be shown to act via the respiratory system, thereby becoming fumigants although applied to the plant in liquid or solid form.

The application of the insecticide or fumigant to the plant depends on their physical condition. Thus we have :—

(1) Spraying, when the material is applied either as an aqueous solution, a suspension, or an emulsion ;

(2) Dusting, when the material is applied either as a finely divided powder or absorbed upon a finely divided "carrier" ; or

(3) Fumigating, when the chemical is applied as a gas.

Of these three methods of application spraying is the one most widely used at the present time.

Spraying.

Not only should a spray be effective against the insect against which it is applied, but it is essential also that it should not cause injury to the plant. The sensitiveness of the plant to the spray, in a general way, will vary with its stage of development ; the spray to be used against the leaf-eating insect must not cause injury to the foliage, but if the spray is applied to kill insect eggs or hibernating insects upon the tree trunk the question of foliage injury becomes less acute. We may, therefore, make an arbitrary distinction between those sprays applied during the period of active plant growth—the summer sprays—and those applied during the dormant period—the dormant or winter sprays. For an example of this we may turn to a tar distillate spray, which, while proving of excellent value as an ovicidal spray during the months of June and early July on deciduous fruit trees, would cause extensive burning to the foliage and fruits of a tree if applied during the growing period.

It is essential also that the spray should cover the whole of the surface upon which it is to act. A contact spray must be able to make contact with the insect to be killed, a protective spray must cover the entire leaf surface it is to protect. Finally, in most cases where the toxic chemical left by a spray is to act as a protective agent or as a stomach poison it must remain on the plant surface. Loss by mechanical agencies, washing off by rain or by chemical decomposition will reduce the efficiency of the spray.

To summarize, the following are the points by which the effectiveness of a spray may be judged :—(i) its toxic action as an insecticide ; (ii) its non-injuriousness to the plant ; (iii) its capability of covering the entire plant or insect surface ; and (iv) the formation, in certain circumstances, on drying of a film which either adheres to the plant or is more or less permanent and unchanged by atmospheric agencies.

The toxic action of the chemical and its action on a plant are properties which are characteristic of the particular chemical in question, and it is perhaps better to discuss these various properties when the different insecticides are considered later. The chemical may be applied as an emulsion, a suspension, or as a solution which must not only satisfy the requirement No. iii

Types of Spray Deposit.

A—Apple sprayed with lead arsenate alone. B—Apple sprayed with lead arsenate to which casein spreader has been added.

(i.e., covering capacity), but also, after drying, must leave, in the majority of cases, a deposit which fulfils the requirement No. iv. It is possible nowadays, by the addition of other components, to modify the properties of the various spray fluids so as to fulfil better requirements iii and iv. It is obvious, of course, that these additional materials must cause no serious interference with the other requirements of the spray by reactions which reduce the insecticidal value or which render the plant more liable to injury. There are several types of materials which are added to sprays with a view to aiding, firstly, the covering of the surface of the plant, and, secondly, the adherence of the toxic chemical to that surface. These are called respectively *spreaders* and *stickers*.

Spreaders.

Spreaders are added to insecticides with the object not only of securing a more complete covering of a plant surface, but also to enable the liquid to make intimate and complete contact with the insect against which it is to act. It is common knowledge that water falling on a plant as rain, or in some other such circumstance, does not readily spread over the leaf surface, but forms large drops which run off without wetting the leaf. The same thing, but perhaps to a lesser degree, happens with sprays; either they would completely run off the leaf, or would be left in large drops which, in drying, would leave an uneven deposit of the toxic chemical.

The various spreading agents which find practical application at the present time include soap, saponin, casein derivatives, and gelatine.

Soap was probably the first of the spreading agents to be used to increase the efficiency of insecticides. As far back as 1821 a man named Robertson (*Trans. Hort. Soc. London*, Vol. 5, p. 175, 1824), working on the problem of the control of mildew on peaches by the use of sulphur, stated: "It should be mixed with soapsuds and then applied by dashing it violently against the tree." Chemically the soaps comprise a large number of separate compounds which are all alkali salts of the higher fatty acids. The hard soaps of general use are sodium salts, whereas the soft soaps usually employed for admixture with the various spray materials are potassium salts.

Although all soaps are capable of increasing the wetting power of water the potash soft soaps are considered better for spraying purposes, partly at least because of their readier solubility. Soaps which are to be employed for domestic purposes usually are prepared from relatively pure vegetable and animal fats. Because of the demand, notably in America, for cheaper soaps for spraying purposes, cruder and less expensive sources of the fatty acids have been used. The fish oil soaps, for example, are made from the cheaper whale and herring oils. Frequently, also, resin is employed as a substance which reacts with alkali to form a resin soap, which consists mainly of the alkali abietate. Strictly speaking, this substance

is not a true soap, but is often employed as a substitute for, or for admixture with, the true soaps.

Soaps react most readily with metallic bases, other than the alkalies, to produce an insoluble resinous precipitate, a reaction which prohibits the addition of soap as a spreader to many of the insecticides commonly used. Further, for this reason it is necessary to avoid the use of hard water for the preparation of the spray as the calcium and magnesium salts present not only destroy the wetting powers of the spray, but also produce a curd which may interfere with the application of the spray to the plants. Potash soaps are said to give a less gritty curd less liable to clog the spray nozzles.

The *saponins* form a group of glucosides—chemicals which, by hydrolysis, or by the action of specific enzymes, yield sugars and other compounds of a non-carbohydrate nature, the sapogenins. The saponins were early distinguished by their property of dissolving in water to form clear solutions which froth well on agitation. The first utilization of saponins for spraying purposes appears to have been made by Bedford and Pickering in 1910. Saponins are present in varying amounts in a wide variety of plants, but the more important sources of commercial saponin are the inner layers of the bark of a plant *Quillagia saponaria* (Soap Bark), and the pericarp of the fruit of *Sapindus utilis*. The cost of extraction renders the price of pure saponins prohibitive for commercial spraying, but there are, at the present time, several saponin preparations on the market at a price which should not be prohibitive for practical employment.

Casein Derivatives.—Many water soluble derivatives of the proteins, such as albumen and casein, are able to increase the wetting power of water. In 1913 two French workers proposed the use of the relatively cheap and abundant by-product casein with alkaline bordeaux mixtures, to promote the wetting properties of the spray. This material proved most successful, and many casein preparations are now available for spraying purposes. Most of these are commercial preparations, such as lime caseins or calcium caseinates—powders containing casein and calcium hydroxide in various proportions. Robinson (*Jour. Eco. Ent.* 1924, 17, p. 396) has suggested the direct employment of skim milk, mainly on account of cheapness. He added the milk to the spray tank, rendering the casein soluble by the subsequent addition of hydrated lime or slaked quicklime, which also serves to neutralize the acidity of the milk; the toxic spray material was added last. Skim milk is used by some Victorian orchardists for this purpose at the present time.

Gelatine also has been used as a spreader by some workers, particularly with fungicides. Although not possessing the popularity of a lime casein, gelatine has advantages as a spreader. Chemically it is more inert than the previously mentioned materials with the possible exception of saponin, but, like that material, is probably too expensive in a pure state for use in large amounts. However, this may be overcome by using cheaper and impurer forms such as glue and size.

The explanation of how these materials are able to bring about the improved spreading qualities is still obscure. The problem of obtaining a good spread finally resolves itself, however, to securing a good wetting of the surface. Wetting power and spreading power are not quite synonomous, as, before a liquid is able to spread, it must first wet the surface. Once this is secured the question of spread depends upon the mobility of the liquid under consideration. It is possible that there are several factors involved in the wetting action, one of which is certainly the effect of the substance on the surface tension of its solution. Some workers have stated that the wetting powers of the solutions may be dependent less upon the surface tension than upon the surface viscosity. This surface viscosity arises from the concentration of the solute at the surface layer of the solution. Indeed, when the surface tension of the liquid is diminished by the addition of the solute, it has been shown that the solute becomes more concentrated in the surface layer, i.e., the solute is adsorbed by the surface layer. It may be, that not only does this superficial concentration bring about the lowering of the surface tension, but it may influence other properties such as the viscosity of the surface layer. The wetting power of saponin, solutions, which is greater than would be supposed if surface tension were the sole criterion, has been attributed to this peculiar surface viscosity, which prevents the breaking up of the liquid film to form drops.

No satisfactory method for the measurement of the wetting power of the liquid has yet been evolved. Apart from the determination of the surface tension, attempts have been made to measure the emulsifying power and the frothing power of the liquid, properties with which the wetting power seems to be closely related. The ability to form a stable froth indicates that the liquid possesses—(1) a low surface tension, and (2) a high surface viscosity. In dilute soap solutions the first factor would appear to be predominant; in saponin solutions it is the second factor which plays the greater part.

It is questionable, however, whether, even if an accurate measure of wetting power against one specified solid were available, it would be of practical use, for the plant surfaces to be sprayed are so diverse in character, while, in addition, the spray may have to cover the various chitinous surfaces of the insect.

Stickers.

"Sticker" is a term applied, usually in America, to those substances which when added to the spraying liquid improve the adherence of the toxic chemical to the leaf or insect surface. Stickers are used primarily when the spray is to leave on the leaf a deposit which otherwise would be easily removed by rain, dew, or wind, and would, therefore, fail to protect the plant for the requisite length of time. Such sprays usually are in the form of a suspension or solution, which on drying decomposes to form a film active against the insect. If a suspension be employed, the finer the particles the more adherent will they be to the leaf surface; the finer the deposit the less likelihood there is of it being washed off. Hence to secure good sticking it is essential that a spray should be prepared so that the ultimate particle which adheres to the foliage should be as small as possible.

The action of the spreader simultaneously increases this adherence of a spray, for if it were to collect into drops the particles of deposit would be lost in the dripping from the foliage or would be left in large aggregates which, like the coarser particles of the suspension, would be easily removed by external agencies. Thus arises an important supplementary result of the use of spreaders, and incidentally the fact that all spreaders are in turn stickers.

In addition to the spreaders other materials have found practical employment as stickers. The majority of these supplementary materials are of the adhesive type, the idea underlying their use being to gum the particle to the surface spray. Flour paste, starches of various kinds, gums, such as gum arabic, dextrins, and crude treacle or molasses have all been proposed and used.

Dusting.

In certain cases, where it offers particular advantages from the point of view of the grower, dusting, or the application of a toxic material in the form of a finely divided powder has almost superseded spraying. Dusting eliminates the difficulties involved in the use of large quantities of water, preparation of the material is easier, indeed, the dust may be purchased ready for application. The expense of time and labour for the preparation of stock solutions and the cost of mixing vessels and platforms disappear, while, in cases of urgency, the material is available without delay. Lastly, the apparatus employed being lighter than water-carrying sprayers, the work involved in the application is reduced.

Dusting with a Hand-blower. (Note the Y attachment to cover two Rows.)

On the other hand it is by no means established that in all cases the control secured by dusting is as efficient as that obtained by spraying. Undoubtedly, in some cases the reverse may hold: the light powder drifts better than a heavy spray, resulting in a better penetration on to the underlying foliage. The lightness of the dust, however, makes it possible to apply the powder only when there is but little wind, and spraying is practicable under conditions when dusting may be impossible. Again the fine cloud produced by dusting may cause great inconvenience to the man employed in the work, while it is questionable whether the adherence of the dust particles is in all cases as good as that secured by spraying with the aid of spreaders and stickers. To secure a satisfactory protective action, it is often necessary to dust only when the foliage is wet with dew or rain.

Dusting at the present time seems to have established itself in the routine of market garden insect control, and also in isolated cases in the control of insects attacking forest trees. Such a case occurred here in Victoria within the last

two or three years when the State Forestry Pine Plantation at Yarrowee was severely attacked by the Case Moth (*Clania tenuis*). This insect was stripping the foliage of the pines (*Pinus radiata*), and in some cases the trees were so badly affected that they had died. Several applications of calcium arsenate, in dust form, were applied to these trees from an aeroplane, with the result that more than 95 per cent. of the larvae of this moth were killed and the less severely affected trees eventually recovered.

INSECTICIDES.

Mention has been made previously of the various groups into which spray materials are classed, depending mainly on the method of action of the insect in question, viz.—stomach poisons, and contact poisons.

Stomach Poisons.

Of the stomach poisons most commonly used as insecticides, the arsenic group is by far the most important. Although arsenic was known long ago to be poisonous to insects, its use as an insecticide became general only about the middle of last century. In France, the use of arsenicals for the destruction of insects was prohibited by the French Ordinance of 1846, but so successful was their employment in the United States that their re-introduction into Europe was inevitable. The more important of the arsenical compounds in use now or within recent years are Paris Green, London Purple, Lead Arsenate, and Calcium Arsenate.

Paris Green.—With the gradual spread of the settler in the United States towards the west, the Colorado Beetle (*Leptinotarsa*), whose home was originally in the Rocky Mountains, migrated towards the east. It found in the potato such an excellent host plant that before long it threatened the entire crop. Desperate remedies were tried, and in 1867 it was found that Paris Green, an arsenical pigment, was a successful means of control. In later years (in 1872 and 1878) the value of this pigment against such insects as the Canker Worm and the Codling Moth was demonstrated, thus establishing the importance of Paris Green as an insecticide.

The main constituent of Paris Green, known also as Emerald Green, French Green, and Mitis Green, is a complex compound of copper acetate and copper arsenite. The material available for insecticidal purposes, made originally by different more or less obscure and indefinite methods from the variable raw material verdigris, was far from constant in composition, the content of arsenious oxide in 44 samples analysed in 1902 varying from 55 to 61 per cent.

However, the methods of manufacture of Paris Green have since been standardized, although the composition of different samples still shows some variation, recent tests showing from 54 to 57 per cent. total arsenious oxide, 1.5 to 4.5 per cent. water soluble arsenious oxide, and from 29 to 30 per cent. copper oxide. It is this high percentage of water soluble arsenic that renders the use of Paris Green so dangerous for spray purposes—in the majority of cases severe burning of the foliage of plants would follow its use.

London Purple.—In view of the success of Paris Green as a control agent for the Colorado beetle, a London firm, in 1878, sent to an American entomologist, an arsenical residue from the manufacture of magenta for trial as a substitute. This material proved successful and was given the name of London Purple. The active principle is arsenite of calcium together with some arsenate of calcium. This material often contains a higher percentage of arsenic than Paris Green, but it proved so variable in character that it ultimately went out of use as an insecticide.

Between the years 1868 and 1893, when lead arsenate was first used, several other arsenicals were tried as substitutes for Paris Green. It was realized that the successful arsenical would have to be of more constant composition and give rise less readily to soluble arsenic, in the form of arsenate or arsenite to which the foliage injury was attributed. Work in this direction finally led to the introduction of lead arsenate.

Lead Arsenates.—Lead arsenate was discovered by F. C. Moulton, and during the year 1893, was introduced as an insecticide for the control of the Gypsy moth in Massachusetts. Subsequent tests showed this material to be superior to the earlier arsenical sprays for combating other chewing insects. At that time, and for many years subsequently, lead arsenate was thought to be a standard product; but varying results secured in the field forced workers to a realization that such was not the case, and recent investigations had shown the existence of several lead arsenates. In fact, it has been shown that the chemistry of certain of these is so complex that it is not possible to do more than speculate as to their composition.

The old time method of producing lead arsenate by causing lead acetate to react with sodium arsenate has long been superseded by a more up-to-date method which produces a purer and

more stable article. The crude admixture of lead acetate and arsenate of soda produces what is termed a basic arsenate in which the arsenic (arsenic oxide) content is about 25 per cent., which is comparatively low, and the lead (lead oxide) content high, approximately 75 per cent., the ratio of arsenic to lead being as 1 to 3. In recent years the method of manufacture in general use on both sides of the world is one termed the "acid" method, which consists of dissolving arsenious oxide in vats with nitric acid and then adding a calculated quantity of lead oxide. The resulting white deposit is either packed in containers and sold in paste form, or where the dry powder is required, the paste is filter pressed and artificially dried until practically moisture free. This method, when properly controlled, produces a consistently pure acid lead arsenate, having a high arsenic (32 per cent.) low lead (64 per cent.) ratio of approximately of 1 to 2, and in this respect, differs greatly from the acetate arsenate method.

Apart from the variation in the percentages of arsenic and lead, there are other pronounced differences between the two lead arsenates, particularly in regard to density and toxicity. Acid lead arsenate with a density of approximately 5·8 is much lighter than the heavier basic salt with a specific gravity of 7·1, while the former compound, by virtue of both its physical and chemical composition, possesses a much greater toxicity or killing power. It has been demonstrated that there are no less than six possible lead arsenates, but the only two produced commercially are the acid and basic forms—

(*a*) Acid lead arsenate constitutes about 85 per cent. of the lead arsenate of commerce, and almost 100 per cent. of that used in Victoria. It possesses a theoretical composition of lead oxide, 64·29 per cent.; arsenic pentoxide, 33·13 per cent.; and water of constitution, 2·58 per cent.

(*b*) Basic lead arsenate was first used in the United States in 1911, but since then it has had a very limited demand in that country, being used mainly on peaches. There has been little or no demand for this product in Victoria probably owing to the difficulty of procuring a genuine product. Basic lead arsenate has the theoretical composition of lead arsenate, 75·9 per cent.; arsenic pentoxide, 23·5 per cent.; and water of constitution, 1·6 per cent.

A Compressed Air Sprayer.

Units of Measurements of Arsenates.

The *Fungicides Act* 1928, of Victoria, requires all brands of lead arsenate on the market in this State to conform to the proclaimed standard, i.e., "They shall contain not less than 25 per centum of arsenic pentoxide combined with lead, and not more than 1 per centum of water soluble arsenic compounds calculated as arsenic pentoxide, both calculated on the dry basis." Thus, so far as Victoria is concerned, there are two definite units of measurement—arsenic pentoxide content, and water soluble arsenic content. In other parts of the world other units of measurements are used, and a brief discussion on some of these may be interesting.

(*a*) *Percentage of Arsenic Pentoxide.*—As the quantity of arsenic used as a spray is determined largely by the percentage of arsenic contained therein, it is important that this be expressed in some standard form. The arsenic content may be given in percentages of arsenic trioxide (As_2O_3) or of arsenic pentoxide (As_2O_5). Although many American manufacturers give this content as arsenic trioxide it is preferable to have it expressed as the arsenic pentoxide as this is the form in which the arsenic occurs in the spray.

The quantity of arsenic pentoxide theoretically present in the acid lead arsenate is 33·13 per cent. and analyses of the brands present on the Victorian market show that the commercial

preparations agree closely with this theoretical figure ranging from 30 to 33 per cent. A table showing the analyses and water soluble contents of various arsenates of lead on the market appeared in the September, 1934, issue of this *Journal*.

The quantity of arsenic pentoxide theoretically present in the basic lead arsenate is 23·5 per cent. If this content were used as a measure of dosage then approximately one and a half times as much of the basic form of arsenate of lead would be required to give the same results as if the acid form were used. Actually it has been shown that twice the amount is required, so that it is evident that the dosage of the basic lead arsenate must be computed on a different basis from that of arsenic pentoxide content.

(*b*) *Percentage of Lead Oxide* (*PbO*).—The base, lead oxide, is practically worthless as an insecticide so does not afford a measure of dosage. However, it is necessary to know the percentage present in the lead arsenates, as from them (and the arsenic pentoxide content) can be calculated the lead : arsenic ratio necessary to determine the acidity or basicity of each arsenate.

(*c*) *Water Soluble Arsenic Pentoxide Content.*—As injury to plants is due to the water soluble arsenic content, it is necessary to use brands in which this has been reduced below a safe maximum amount. In Victoria the amount allowed by law is up to 1 per cent., in the U.S.A., the insecticide regulations require that not more than 0·75 per cent. of water soluble arsenic be present, while in New Zealand, the maximum is 0·2 per cent. As far as Victoria is concerned an analysis of the commercial brands of arsenate of lead shows that the percentage ranges from 0·2 to 0·4 as a general figure, while in some cases it may reach 0·7 per cent.

(*d*) *Particle Size.*—While this factor has received very little attention up to the present time from investigators or manufacturers, some countries are now claiming that size of particle is most important in determining the toxicity of an arsenate. The argument put forward in favour of this is that the amount of poison that can be taken into the stomach of an insect by way of the mouth, and the ability of the arsenate to adhere to fruit and foliage, depend on the fineness of the particles. In New Zealand the mouth parts of a large number of newly emerged larvae of the Leaf Roller moth were measured and were found to range from 75 to 100 microns in diameter (1 micron is approximately 1/25,000th of an inch). However, these insects were found to be capable of ejecting minute particles of the poison with a diameter of 10 microns. It has been assumed arbitrarily in New Zealand that 10 microns is the effective maximum for particle size, and on this assumption a possible explanation for the conflicting results secured in the toxicity study with different arsenates has been put forward. To illustrate this point, Table I. shows the analyses of several brands of arsenates at present on the market in New Zealand.

This factor of particle size possibly may be utilized as some measure of the relative efficacy (other particulars being equal) of the different commercial arsenates, but further work is necessary before any definite statement can be made on the matter.

TABLE I.—SIZES OF PARTICLES OF ARSENATES.

Particle Size in Microns.	Sample of Lead Arsenate.				
	A.	B.	C.	D.	E.
	%	%	%	%	%
Above 74 microns	0·1	2·1	4·3	1·1	0·1
Between 74 and 10 microns ..	0·0	27·0	1·0	13·0	1·0
Total above 10 microns ..	0·1	29·1	5·3	14·1	1·1
Between 10 and 5 microns ..	0·3	21·0	7·0	16·0	4·0
Under 5 microns..	99·6	49·9	87·7	69·9	94·9

THE USE OF ARSENATES AGAINST INSECTS.

Arsenate of lead, as previously stated, is the effective spray material for use against those insects which obtain their food by biting out portions of the plant tissue and passing the food down into the stomach. By far the most important use of arsenate of lead in Victoria is against the Codling Moth (*Carpocapsa pomonella*), an insect which causes severe damage to apples, pears, and other orchard crops. It is estimated that at least 10 per cent. of the total apple crop of the State is destroyed annually by this insect. Until recently arsenate of lead has been practically the sole spraying material used against this insect. It is applied in the form of a spray at the rate of about 5 lb. of arsenate of lead paste (or 2½ lb. of powder) to every 80 gallons of water, and it has been found necessary to apply as many as eight or ten sprays in some districts to obtain efficient control. Although satisfactory control of the codling moth was obtained, the fruit, at picking time, was plastered with arsenate of lead far in excess of the amount allowable by law. In Great Britain and certain

Australian States it is provided that fruit exposed for sale must not contain more than 0·01 grains of arsenic trioxide per lb. of fruit. This regulation is very rigidly enforced in Queensland and overseas. Where several sprays of arsenate of lead are used, particularly in the latter portion of the season, it is impossible to keep below this limit, with the result that the fruit has to be hand wiped or chemically washed in dilute hydrochloric acid or some other solvent.

Experiments conducted by the Department of Agriculture in several districts of Victoria have shown that it is possible to devise a spray programme which will give a more efficient control of the codling moth and yet keep the spray residue below the prescribed limit. This has been accomplished by the use of white oil emulsions, and will be discussed later under that heading.

Calcium Arsenate.—Although the use of lead arsenates as insecticides has met with the greatest success, the lead appears to play no important role. Because of its heaviness the desirability of the replacement of the lead by a lighter metallic radicle led to the commercial production of calcium arsenates free from water soluble arsenic. Apart from London Purple, arsenites of calcium had been suggested previously and used as insecticides in 1889, but owing to many cases of foliage injury did not become of great importance.

The chemistry of the calcium arsenates, is in many ways, similar to that of the lead arsenates. The main ingredient of the commercial calcium arsenates is the dicalcium hydrogen arsenate $CaHAsO_4$. However, this material is too soluble for safe application to the foliage, and consequently is rarely used as a spray material, unless an excess of lime is present. A further important difference between the lead and calcium arsenates employed as insecticides is that the lead arsenates are relatively stable and undergo but little change after application to the foliage, whereas the basic calcium arsenates suffer decomposition.

Calcium arsenate finds little use at the present time in Victoria as a spray material, but is extensively used in the preparation of poison baits against such insects as grasshoppers, cutworms, and in the garden for the control of snails and slugs. A typical poison bait for this purpose would be made from the following materials:—Bran, 10 lb.; molasses or treacle, 2 lb.; and arsenate of calcium, 1 lb.

Miscellaneous Arsenicals.—In some tropical countries the health regulations are extended to include the prohibition of lead residues on fruit. This has led to the investigation of other compounds containing arsenic, and the following materials have been used:—Zinc arsenate, zinc arsenite, manganese arsenate, magnesium arsenate, and several others. Experiments have shown that none of these compounds is likely to replace lead arsenate in a commercial way.

The Fluorine Group.—Sodium fluoride is an old and well-established cockroach poison, which is being used extensively in other parts of the world for the control of silverfish and ants. It is used entirely in powder form. It cannot be used as a spray material as it is only moderately soluble in water.

The silico-fluorides — mainly of the metals sodium, potassium, and barium — have been suggested as substitutes for arsenate of lead. One of these materials, a barium silico-fluoride has been tested out under Victorian conditions, but has not produced results satisfactory enough to warrant any further extended trials.

Rotenone.—Recent advances in chemical research have indicated the value of rotenone as an insecticide. Among the natives of the Malay Archipelago and other tropical areas the roots of certain plants are commonly used for fish poisons. The commonest of these plants appears to be Derris (*Derris elliptica*), a member of the family Leguminosae. In 1848 it was discovered that the ground-up roots of this plant possessed a very definite insecticidal value, and since that time great strides have been made in the use of this product. The active principle from an insecticidal point of view is a chemical compound known as rotenone, which is supposed to approximate to the formula $C_{19}H_{18}O_5$. One of the main disadvantages of the use of Derris roots as an insecticide is that the rotenone content of samples of roots from different localities varies very considerably. For example, it has been shown that, in America, the rotenone content of commercial Derris roots may vary from nil to 5·5 per cent. with a total ether extract ranging from 5 to 23 per cent.

As an insecticide Derris is capable of acting as both a contact and stomach poison. As a contact insecticide, it is of approximately the same order as nicotine sulphate. As a stomach poison it is claimed to possess properties equally as satisfactory as arsenate of lead, and it has the advantage also of not being toxic to human beings. Very few detailed experiments have been made with Derris in this country.

Contact Insecticides.

There are numerous types of materials which act as contact insecticides, e.g., nicotine compounds, lime sulphur, oil emulsions, quassia, &c.

Nicotine Compounds.—Nicotine appears to have been used as an insecticide for nearly two centuries, the earliest authentic reference being a suggestion in 1746 on the part of the English botanist, Collinson, to an American colleague, that he employ an aqueous extract of tobacco leaf to combat plum curculio attacking nectarines. Towards the middle of last century tobacco was regularly used by English gardeners and nurserymen for combating insect pests of plants grown under glass. During this period it was employed in the form of a spray prepared by soaking leaves in water, as a dust prepared by pulverizing the dried leaf, or as a fumigant when dried leaf was burnt in the glass-house. But it was not until nicotine was available in concentrated form that it was employed widely as an orchard spray. In 1885 a concentrated product "Gold Leaf Extract" was placed on the market in the United States, and was followed within a year or two by nicotine sulphate, the success of which led to the establishment of nicotine in the regular spray programme.

In Victoria tobacco wash, prepared by macerating tobacco leaves and stems in water, was recommended many years ago as an aphicide. Concentrated nicotine did not come into general orchard use until about 1920, and since that time has been employed against most sucking insects, both in the orchard and in the suburban vegetable and flower gardens.

Nicotine is an alkaloid extracted from leaves and stems of tobacco plants, the two species *Nicotiana tabacum* and *N. rustica* being employed for the purpose. The nicotine content of plants varies considerably, ranging from 0·75 per cent. in dried stems and midribs, 3 or 4 per cent. in the leaves of *N. tabacum* to 6 to 8 per cent. or more in the case of *N. rustica*. Commercial concentrates are prepared by steam distillation and are available as aqueous extracts containing 7, 10, 40, or 50 per cent. of nicotine, as nicotine sulphate—a salt prepared by treating nicotine with sulphuric acid and containing 40 or 50 per cent. of nicotine—or in the concentrated form with a 95 to 98 per cent. nicotine content. Pure nicotine is a colourless (changing to dark-brown on exposure to light) volatile, poisonous liquid, soluble in water, with a specific gravity of 1·01, and possessing a powerful odour.

The value of the nicotine preparations lies in their efficacy as insecticides, the facility with which they may be applied, and the margin of safety in their use. At specified concentrations they effectually kill soft-bodied insects, such as aphis with which they come in contact; they may be used as a spray, dust, or fumigant; and are harmless to most plant tissues.

Spraying Trees with a Pressure Pump.
Inset shows distribution of spray on a plate fastened at the top of the tree. Highly magnified.
[U.S. Dept. of Agri.

The effectiveness of these compounds as insecticides depends upon the nicotine content, therefore, this factor affords an efficient unit of measurement. Many methods have been employed for the estimation of the nicotine content of tobacco and of insecticides prepared from it. They are roughly as follow:—

(*a*) Methods involving extraction with ether followed by evaporation of the ether and steam distillation;

(*b*) Methods involving simple extraction with ether; and

(*c*) Precipitation methods.

The action of nicotine on insects has received relatively little attention. Most workers are agreed that when applied as a spray the solution

does not pass into the tracheae nor penetrate the integuments. The nicotine acts apparently purely as a fumigant, the vapour passing into the tracheae and there being widely distributed to all tissue, death being induced by paralysis of the nervous system. This belief is supported by field practice, for nicotine preparations are most effective when applied under conditions which bring about their rapid and complete volatilization.

The outstanding feature of nicotine, whether used as a spray, dust, or fumigant, is that it is rarely toxic to plant tissue, even when applied at dosages greatly in excess of those necessary for complete killing of insects. It is noteworthy that violet plants are very susceptible to nicotine sprays, the leaves taking on a brown blotchy appearance. An additional advantage is that no spray deposits are left upon the plant tissue.

The volatility of nicotine, upon which its efficacy largely depends, is affected by such factors as the temperature at time of application, the form in which it is applied, and the presence of additional materials in the vehicle of application. Nicotine will volatilize within a reasonable time after application, provided warm weather is experienced, but volatilization is materially improved by the addition to the spray or dust of certain agents which have been variously termed "activators," "liberators," or "boosters." Where nicotine sulphate is employed an activating agent is essential, otherwise the nicotine is released so slowly that the spray or dust is practically worthless as an insecticide. As an activating agent, soap has been long employed. As far back as 1918 it was claimed that the insecticidal value of nicotine was increased nearly 50 per cent. by the addition of soap. Other nicotine preparations used for sprays are known as nicotine oleate, nicotine tannate, and neo nicotine.

Nicotine sprays usually are applied at concentrations ranging from 0·05 to 0·125 per cent. for combating soft-bodied insects such as aphides and thrips. Control is secured only when the sprays are brought into close contact with the insects in question. For such pests as woolly aphis or mealy bug, where the insects are protected by a woolly or mealy coat, the use of nicotine in combination with a summer oil is advisable.

Nicotine dusts have been used for many years. In the olden days they were prepared by pulverizing tobacco leaves, and the dust had a variable content. At the present time the commercially prepared dusts contain known quantities of nicotine or nicotine sulphate added to an inert carrier such as kaolin, magnesium, or calcium hydroxides.

To prepare a "home-made" extract suitable for spraying, tobacco leaves should be broken up as finely as possible and treated with water. Three gallons in all are required for each pound of dried leaf, and are used in three successive steeps, the water being changed every 24 hours. This time may be shortened to four hours by heating the water to 140° F., but higher temperatures should be avoided owing to the possibility of loss of nicotine through volatilization. The three extracts are then combined and filtered through cheese cloth. The combined extract consisting of three gallons has an approximate nicotine content of 0·1 per cent.

Pyrethrum.—When dried and ground to a powder, the flowers of the plant pyrethrum (*Chrysanthemum cineraraefolium*) form a raw material for the manufacture of a most effective and conveniently used insecticide. Pyrethrum is believed to have originated in the Mediterranean regions. It appears to have been known in Persia for its insecticidal properties for many centuries. The early nineteenth century saw its introduction, or re-introduction, into Europe from Persia. Then, as now, it was the red flowered common species (*C. roseum*) that was grown in that country. During the period 1850 to 1860 a new and more valuable species (*C. cineraraefolium*) was produced in Dalmatia. It was white or yellow flowered, and this type is the most widely cultivated of the present-day forms. In 1881 Japan introduced the plant from Dalmatia and, following successful cultivation, now produces at least 80 per cent. of the world's yield of flowers. Austria and Jugo-Slavia also produce pyrethrum in fairly large quantities, while France, Switzerland, Spain, North America, and the Argentine grow the plant to a limited extent for home use. At the present time America imports about 9,000,000 lb. of pyrethrum annually. During the period 1927–32 Australia imported an average of 225,000 lb. annually.

The toxic ingredients of pyrethrum flowers appear to be two fairly closely related compounds known as pyrethrin I. and pyrethrin II. They are present to the extent of only 0·2 to 0·3 per cent., and consist of approximately 40 per cent. of pyrethrum I. and 60 per cent of pyrethrum II. Pyrethrin I. is ten times as toxic as pyrethrin II. when used against the same insect. Recent tests have shown that pyrethrum flowers which are fully open contain from 18 to 61 per cent. more pyrethrin than the closed flowers.

In certain circumstances there may be a rapid loss in the pyrethrin content of pyrethrum flowers. Such factors as heat, sunlight,

Spraying in a Victorian Orchard.

ultra-violet light, and natural ageing are partly responsible for this deterioration. In all cases a decrease in pyrethrin content, as determined chemically, corresponds to a decreased toxic effect on insects.

The value of pyrethrum lies mainly in the fact that it is a contact insecticide. Its principal use, up to the present, appears to be in the manufacture of commercial fly sprays, very little use being made of pyrethrum for orchard work, although it is considered by some investigators to have a definite value in the control of thrips. The rapid deterioration of the material in sunlight militates against its use in the orchard.

In the manufacture of commercial fly sprays from pyrethrum, the flowers are soaked in kerosene for a definite period until all the active ingredients are dissolved. The material is then filtered, and methyl salicylate is added to the liquid to impart a pleasant odour. If the material is then kept in a tightly corked container, very little deterioration will result.

The Oil Series.—The occurrence of species of scale insects resistant to hydrocyanic acid gas stimulated research work on oil sprays in the United States of America. The first oil to be used as an insecticide was kerosene, which came into use about the middle of last century. At first undiluted kerosene was applied with a brush to dormant fruit trees, and it was not until 1880 that this oil was used as a spray. In that year Bernard, in the United States of America, suggested that it should be applied in the form of an emulsion, prepared with milk and diluted with water. The following year Hubbard introduced his "kerosene butter," a heavy emulsion prepared by forcing kerosene and water several times through a spray pump. In 1882 Hubbard introduced kerosene soap emulsion, the success of which led to the general adoption of this spray as an insecticide. This material fulfilled one requirement in that it was reasonably effective. However, the emulsion gives very little margin of safety to the trees, and has since been displaced by the miscible oils. These are refined petroleum oils in which is dissolved a soap or some other substance which enables the oil to be readily mixed with water to produce a stable emulsion. These miscible oils have been in use for a considerable period.

Later, another type of oil spray known as an oil emulsion was produced. These oil emulsions are prepared by dissolving an emulsifier such as calcium or ammonium caseinate in water and adding the oil. When violently agitated the mixture breaks up into small globules and forms a stable emulsion.

In California a third type of oil spray is finding much favour and is generally recommended. This is the so called tank-mixture type. The

pure oil is added to the water in the spray tank and an emulsifier, commonly powdered blood albumen spreader, is stirred in and the whole then violently agitated. The agitation is a most important part of the preparation and must be maintained throughout the spraying. The greatest advantage of a tank mixture spray is that growers are enabled to prepare an oil spray of known and definite properties. In practice two grades of oil are supplied, a light oil and a heavy one. By mixing these in various proportions, a number of different grades may be prepared in accordance with the requirements of the trees to be sprayed. The biggest objection in this State to this type of spray preparation is that the spray machinery at present available here is not capable of maintaining a large size agitator at the rate of 200 revolutions per minute, a speed which is required to keep the proper admixture of oil, water, and spreader.

So far as Victoria is concerned the greatest practical result of the research work overseas has been the production of the so-called white oils. These white oils represent a distinct advance on the old red miscible oil. The improvement is not so much in increased toxicity to the insect—indeed, certain of the red oils are definitely superior to many white ones in this respect—but rather in the reduced liability to damage to the trees. In this particular, the difference between the two is great, and much of the objection to the use of oils, particularly on citrus, disappears when white oils are used.

The value of oils against scale insects—one of their main uses—depends both on the efficiency of the material as a lethal agent and its effect on the trees. These properties are governed largely by the purity of the oil, its volatility, i.e., the rate at which it will dry and evaporate, and the amount left on the tree after spraying. The purity depends on the extent to which unsaturated hydrocarbons are present. These unsaturated hydrocarbons, which are very poisonous to plants, are removed from the crude oil by the use of sulphuric acid, and the purity of the oil is expressed in terms of the percentage which remains unchanged when treated with sulphuric acid. By modern processes, oils can be highly refined without undue increase in cost, and this represents one of the most important advances made in respect to oil sprays. Under normal conditions an oil must be at least 90 per cent. pure to be quite safe as a spray material. Any oil under this standard must be used with care, and generally it is found that the less pure oils must be used at considerably lower temperatures than those complying with the above conditions.

The more volatile an oil the quicker it will evaporate, and as oils must remain on the insect for a certain length of time to cause death, too light an oil cannot be used for insecticidal purposes. However, when an oil spray remains on the plant it penetrates the tissues to some extent and the longer it remains, within certain limits, the more oil there will be absorbed by the plant. A little oil may be absorbed without appreciable ill effects, and the more vigorous the plant the greater the amount which may be absorbed without prejudice to the health of the plant. In larger quantities, however, the absorbed oil may cause death to that part of the tree. Thus, though to effect a kill of the scale insect the oil must not be too light, it must not be so heavy that the plant is adversely affected.

When an oil spray lodges on the tree the emulsion is broken down and the oil and water separated. The rate at which this separation takes place depends, to a large extent, on the efficiency of the emulsifier. If the quantity of spray which falls on a leaf is not more than is actually required to wet it, all the oil in that amount of spray will, of course, remain on the leaf. In actual spraying, in order to ensure that every part of the tree is covered, much of the tree will receive a great deal more spray than is actually necessary to wet it. As soon as a leaf is wetted any further spray lodging on it will commence to run off. It has been shown experimentally that when *free* oil comes in contact with a wetted surface it does not necessarily run off, but may build up on the oil already deposited. If the emulsion breaks quickly when the spray lodges on the wetted leaf some of the oil will remain to build up, and the run off will contain less oil than would be the case were the emulsion to break slowly. As the amount of oil deposited on the tree directly affects the insecticidal value, the quicker the breaking of the emulsion the greater the efficiency of the spray against the insect. It is of course possible to have an emulsion breaking too quickly, for the more oil that is left the more there will be absorbed into the tree. In practice, however, quick breaking emulsions are necessary and emulsifiers which satisfy both particulars are generally used. The emulsifier also influences the spreading qualities of the spray.

In Queensland an attempt has been made to define certain desirable qualities of oils, and it is stated that for a white oil there should be an unsulphonated residue of 95 per cent., with a viscosity (Redwood) of 1 at 100° F., 60 to 70 seconds. For a red oil the unsulphonated residue should be 75 to 80 per cent., with a viscosity

TABLE II.—CODLING MOTH EXPERIMENTS.

Spray Programs.	Codling Moth Infestation.			Arsenic Residue at Picking Time in Grains of As_2O_3 per lb. of Fruit.		
	1930-31.	1932-33.	1933-34.	1930-31.	1932-33.	1933-34.
	Per Cent. Infection.			Grains per lb.	Grains per lb.	Grains per lb.
(1) Arsenate of lead sprays alone	16·7	7·3	65·9	0·032	0·039	0·025
(2) Arsenate of lead calyx spray followed by white oil cover sprays	6·3	4·3	47·7	0·003	0·006	0·003

(Redwood) 1 at 100° F., 155 seconds. In Victoria at the present time no such information is available as far as oil sprays are concerned.

White oil sprays have been used with considerable success in the control of the codling moth in Victoria. Experiments, conducted by the Department of Agriculture, over a period of years, at Harcourt, Blackburn, and Somerville, have given the results summarized in Table II.

White oil sprays are of extreme value as ovicides, and this is probably the chief factor in codling moth control, although there is some evidence to show that they have a repellant action.

Tar Distillate Sprays.—Tar distillate or tar oil used in spray fluids belongs to the aromatic series of organic compounds and is a distillation product of crude tar. Various forms of tar oil emulsions have been in use as insecticides against fruit tree pests for many years, particularly in European countries. In Germany, the insecticidal value of "Carbolineum" was recognized as early as 1908. This material had, as a basis, certain products obtained from the distillation of coal tar, and was used largely to immunise timber against insects, and later was painted or sprayed on fruit trees. Although it was no doubt improved in the course of years in Germany, Holland, and Russia, apparently it was prepared without a full knowledge of its insecticidal action or of the constituents responsible for the destruction of insects. It appears to have been used chiefly as a contact insecticide against mature insects, its egg-killing properties not being realized.

Modern tar distillate sprays have originated from this rather crude material. In 1921, a tar oil wash was introduced into England from Holland, and investigations were commenced at Long Ashton Research Station, Bristol. The investigations showed that a spray consisting of certain fractions of materials distilled from coal tar would be of great value against some pests of deciduous fruit trees. Moreover, the work indicated that tar distillates would prove of greatest value when used against the over-wintering stages of insects, e.g., eggs. Indeed, it is recognized now that this material possesses a degree of insecticidal efficiency against certain pests which is not equalled by any other known spray material, and as a result of its use some important fruit tree insects have been brought under control. When coal is subjected to distillation processes, at increasingly high temperatures, numerous substances are obtained. According to Cunningham and Muggeridge (New Zealand) the order in which the various groups of compounds appear is :—

(1) Benzines—at temperatures ranging from 40° to 150° C.

(2) Phenols—boiling points 150° to 210° C. Used for disinfectants and insecticides. Carbolic acid and naphthaline are products of this group.

(3) Creosote oils—boiling point 210° to 270° C. Used as wood preservatives and insecticides.

(4) Anthracene oils (Green oils)—boiling point 270° to 400° C. Used as wood preservatives and insecticides.

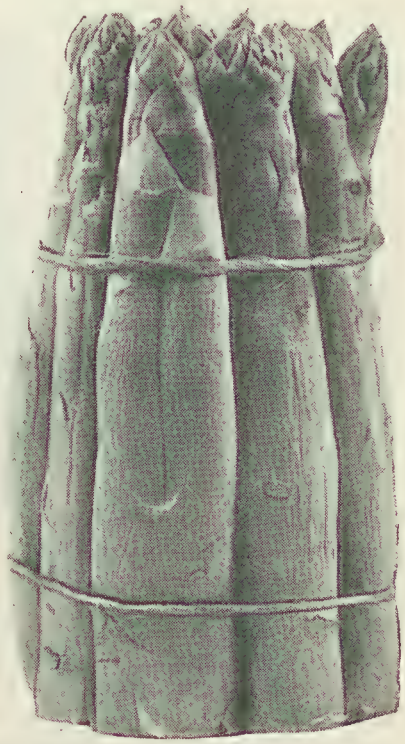
(5) Pitch comprises the residue.

It has been shown that that portion of the distillate boiling above 280° C. is the more toxic to both moth and aphid eggs, and also that the inclusion of phenols or tar acids lowers the toxicity of the material. It is evident, therefore, that the most efficient tar distillate washes should consist of oils contained in the anthracene group.

At the present time tar distillate washes are used with great success in Victoria against the eggs of the green peach aphis (*Myzus persicae*). This spray is applied to the tree in the dormant state and should not be used later than mid-July, otherwise severe burning of the tree may result.

[*Continued on page* 41.

Asparagus Culture



By E. E. Pescott, F.L.S., Senior Horticultural Instructor

THE edible stems of the asparagus plant form one of the most acceptable and healthful of vegetables. *Asparagus officinalis*, as it is botanically known, is a native of temperate Europe and Asia. The old name "Sparagrass" or "Sparrowgrass" is a corruption of the technical name; and the foliage stems of the plant, with their handsome scarlet berries, were commonly known by this name.

All species of asparagus are perennial, with more or less fleshy, tuberous roots. The plant belongs to the Lily family, of which there are ornamental as well as culinary species. In its native habitat, the asparagus plant grows in the sands of the sea-shores; and, while in that location it does not produce large stems, yet it is thoroughly strong and hardy. Asparagus is easy to grow; and, once the bed is established, it perhaps gives less trouble, and requires less attention than many other vegetables more commonly grown.

Probably the main reason why asparagus is not more generally grown, other than its supposed difficult cultivation, is that, being a perennial plant, and producing results only for about three months of each year, it occupies far more space than can usually be spared in an ordinary vegetable garden. While at least two, and often three or four, ordinary vegetable crops may be grown each year, asparagus occupies the land for the whole year, and is therefore bound to remain a more costly vegetable than most kinds. On the other hand, once the asparagus bed is thoroughly established, the work each year is comparatively light, and asparagus can be produced with far more ease than many other vegetables.

Asparagus requires a deep rich loamy soil, heavily stored with strong organic manures, well trenched and drained, and thoroughly cultivated in autumn and spring. These essentials, combined with a special care in preparing the asparagus bed, are all that will be necessary to ensure the establishment of a plot, which will produce good crops for many years.

Preparation of Soil.

The choice of a soil for asparagus culture cannot be given too much attention. It is advisable to have the soil as rich as possible; it can hardly be too rich, especially in organic or humic material. If a rich, deep soil can be utilized, the operations are greatly reduced. Heavy clay soils should be avoided. It may happen, of course, that the scope of the intending grower is limited, and that he already has his land, which he must employ to the best of his ability. If the soil be at all heavy, and particularly of a clayey nature, the clay should be removed, and the heavy soil should be made very much lighter in texture by the addition of humic material.

An old method of preparing an asparagus garden is to dig a pit at least 3 feet deep the full size of the intended bed. All clay, heavy soil, stones, and solid matter are then removed, and the bed filled with rich friable humic soil with a proportion of sand to facilitate draining. The bottom of the pit is covered with a layer of 6 or 8 inches of well-rotted manure and leaf-mould; above that is placed a layer of rich soil or turf, then a layer of manure, and so on, until

the pit is filled. The area is then divided into small plots. Such a bed would produce good crops for years; and no asparagus bed should be laid down without proceeding on the main lines indicated. It is not wise, however, to make up the bed by placing the soil and manures in alternate layers; the rich soil and manure should be well mixed together, so as to form an even mass of material which is a source of rich plant food.

The bed depth of 3 feet is not always necessary. The soil may be worked out to a depth of a little over 2 feet; and then at planting time a good covering of rich soil might be placed to a depth of from 9 to 12 inches, thus providing a raised bed, which would be easily drained also.

A Three-Year-Old Asparagus Crown ready for planting.

The bottom of the bed should be well dug up or trenched, and in order to prevent a lodgment for water, the bed should have drainage exits, particularly where the subsoil is heavy or clayey. In preparing large areas, it would be impossible to follow this system. The soil should be ploughed deeply, without bringing the subsoil to the surface, and it should also be subsoiled, particularly if the latter be not at all porous. A good covering of stable manure should be then given to the field; and the grower will have to rely upon subsequent top dressings with artificial fertilizers to provide nutriment for the plants.

It is beyond doubt that asparagus will thrive better in a friable than in a heavy soil; as, being a native of the sea sands, it requires a loose, free-root area. In preparing the beds, anything that will form plant food or that will tend to open the soil, may be utilized, such as sand, turf, wood ashes, soot, crushed bones, leaves, grass cuttings from lawns, straw, seaweed, in addition to the ordinary fowl, cow, pig, and horse manures. Whatever food ingredients are added to the bed should be well blended together; large heaps of any one substance should be avoided in the beds. It is a decided advantage to have the bed prepared in the autumn, so that the various ingredients may be sweetened and mellowed before the planting season.

In large areas, the depth of the bed can readily be provided for by ploughing out between the beds, throwing the soil well up on the bed; thus providing the raised bed system for the crop.

The principal asparagus growing areas, in the State, are Geelong and East and West Gippsland. In these districts there are several types of soil in which the crops are grown. There is a rich black humic sand at the base of the coastal sand dunes, several feet in depth, in which the roots can travel freely and deeply. The availability of seaweed, from over the sand dunes, makes these areas very suitable; and the addition of seaweed, containing as it does, much potash, cheapens the cost of production very considerably.

Then there are the old lake and river bed areas, which have been built up largely by the decay of rushes and reeds, as well as by the deposition of debris of all kinds.

Thirdly there are the reclaimed swamp areas of the Berwick, Narre Warren, Koo-wee-rup districts, and the alluvial soil of the Mitchell River at Bairnsdale. These soils are deep and rich in humus, from decayed tea-tree foliage and other swamp growths.

Wild Asparagus.

In parts of the State such as the Mildura settlement, and at Quantong and Riverside, near Horsham, asparagus has become acclimatised, mostly on the channel banks. Here the plants grow very freely, and the stems are a source of income to the local inhabitants. Of course, the stems are not blanched, but even with the green colouring, these local asparagus tips and stems are very palatable, and are much in demand.

Planting.

The plants may be set in the rows from June to August. The beds should be arranged so as

to take every advantage of the sun—a warm aspect is needed to induce quick growth in the springtime.

One-year or two-year-old plants may be used. If the yearling plants are strong, with well developed crowns, and three or four buds, they may be planted; they will give as good results as two-year-olds. Seedling crowns are to be preferred to divisions of the older crowns, as the young plants have greater vigour and vitality. The plants should be planted in rows about 18 inches apart in the home garden, with the same distance between each plant. In large areas, the plan of planting in double rows is often adopted, the rows being alternately 2 feet and 3 feet apart. This allows for a furrow or a trench to be run between each double row in the winter, to provide for good surface drainage. The trench is dug deeply, and at a lower level than the crowns, so that there shall be no possibility of surface water settling about the roots in the cold weather. The plants should be placed at least 6 inches below the surface. For planting, a furrow or trench may be run along the length of the bed, and the crowns placed in this. The roots should be directed downwards, so that it will be well to have a slight crown in the centre of the furrow; they may then be covered with soil, and well trodden, care being taken to tread at the sides, and not on the crowns. A top dressing of manure will complete the work of planting. Sometimes, where the soil is not particularly rich, it will be advisable to give a light sprinkling of bonedust or sulphate of potash in the trenches before planting.

If it be desired to grow seedlings, the seed should be planted in a well-drained bed of rich soil, in rows about 2 feet apart. The seed should be sown very sparsely. The young plants should be thinned out to 8 or 9 inches apart. Thorough cultivation should be observed throughout the year; no weeds should be allowed in the seed bed. Frequent waterings with liquid manure, especially in dry weather, will make the results successful.

"Conover's Colossal" is the commercial asparagus more commonly grown; while "Palmetto" is also a good variety, rather earlier than the former; "Argenteuil Purple" is another good variety, and very tender. This last-mentioned variety is often grown in localities where asparagus rust is prevalent. "Deering's Mammoth" is a locally raised variety, which under good culture, produces very large thick stems of first class quality and flavour.

Cultivation and Management.

From springtime to autumn, the beds will require to be continually hoed and cultivated. No weeds should be allowed in the beds; and if these are frequently hoed, no trouble will be experienced from foreign growths. Soil crusts and sodden surfaces must be avoided; and in autumn, and again in spring, the beds may be forked or dug over. If trenches are cut between the rows, the soil may be thrown up on top of the crowns.

In the home garden, it is a good plan to rake or fork away the first few inches of top soil each year, not later than August. This should be replaced immediately with rich strong manure or manure and soil mixed. If animal manure be not available, then a supply of chemical fertilizer should be mixed with the soil.

During the first year, the plants should be allowed to grow without any cuttings being made. If good sturdy growth has been made, the beds may be sparingly cut over during the second year, and then only for four or five weeks. Cutting causes weakness of growth; and, until the plants are sturdily established, they should not be weakened by forcing them to make

Asparagus stems ready for Cutting.

Seedling Asparagus growing on top of crown.

unnatural growths. Subsequently, the beds may be regularly cut over, terminating the third year's cutting time with the end of November, and all subsequent cuttings early in December; with later varieties and in cooler districts the season will be extended. In matured beds, the cuttings should always be "clean." That is, every growth, whether sturdy enough for culinary purposes or not, should be cut out. The stalks that are too small or poor for eating may be thrown away. From December, all growths should be allowed to continue until autumn, when the beds may be cleaned out; all the old growths should be cut down level with the ground, and the beds given a top dressing with stable manure. The tops are cut as soon as the seeds are ripened. These then appear of a bright scarlet colour. The seeds must not drop to the ground, as they will germinate and grow, and the seedlings will become some of the worst weeds in the beds.

Asparagus beds frequently make several growths during the season, or they may, under very favorable conditions, be making continual development of shoots right through the growing period.

Generally there is the spring growth which is always cut out for culinary purposes. Then there is the continued growth which comes after cutting ceases. Later on, early in February, especially if there be summer rains, a very strong re-growth appears.

Manuring.

Even though the plantation had been well manured before planting was carried out, the plants require constant manuring, as asparagus is an exceptionally gross feeder. Dressings of stable manure may be given after cleaning out the beds, and after the beds have been "cut out" and are allowed to grow in December. Seaweed is a valuable mulch for asparagus; and, if available, should be applied in abundance. In addition to these, occasional sprinklings of chemical fertilizers may be given in spring and summer. As frequent cutting for some time, of every growth produced by the plant, is a heavy tax on its vigour and abilities, it should be well nourished with readily available food, so that it may continue to produce good growths; thus, frequent feedings during the growth will always be helpful. The plants cannot continue to bear good payable crops, and at the same time be compelled to continue in growth and existence without special help and assistance.

The most perfect chemical fertilizer for asparagus is a mixture of 2½ cwt. of sulphate of ammonia, 2 cwt. sulphate of potash, and from 4 to 5 cwt. of bonedust per acre. Blood manure, nitrate of soda, kainit, and muriate of potash are all useful for top dressing. Owing to asparagus growing on the seashore in its native habitat, it was supposed that the plants required frequent dressings of salt to enable it to grow successfully. It has been found, however, that such is not the case. Further, on analysis, it has been shown that of all ingredients in the composition of this plant, salt is in the lowest percentage. Salt will kill the weeds without injuring the asparagus; and has an indirect effect in reducing, to an available condition, certain plant foods that already exist in the soil.

Cutting.

With the advent of the warm spring weather, the asparagus stems begin to come through the surface, and they are ready for cutting. They should be cut before the scales on the heads have opened out, the knife being inserted into the ground, cutting the stems below the surface, and

carefully avoiding any other stems that are growing out from the same crown.

There are various asparagus knives in use, but all are made on a similar principle, having the cutting edge at the end, instead of at the side, the end being either at right angles to the side, angular, or curved. A recently invented asparagus knife has its cutting end shaped like a V, both inside edges being sharpened.

Pests and Diseases.

In this State, the asparagus plant is singularly free from these troubles. In America, considerable injury is done by the Asparagus Beetle, which is a pretty beetle with red, lemon, and dark-blue colouring. The beetle causes damage by the larvae burrowing into and eating the young asparagus stems.

Asparagus rust frequently causes considerable damage by attacking the growing stems, and thus weakening the whole plant and interfering with its growth. It is always a safe plan to burn the tops of the plants when they are cut down in autumn; this will destroy effectually both fungus spores and insects that may be lurking therein. In California, great havoc and considerable loss resulted from continued attacks of the asparagus rust. There, both sulphur and Bordeaux mixture have been used with good effects. It has been found also that some varieties are more resistant to rust than others. The "Palmetto" variety stands out prominently as being an excellent rust resistant; while the French variety "Argenteuil" is considered equally rust proof.

Conclusion.

If the field or beds have been well established and well cared for, there is every reason to expect that they shall be productive for many years.

Asparagus canning is a very important industry, and it is now established on a sound commercial basis. "Conover's Colossal" is practically the only variety grown for that purpose.

Insect Control

(Continued from page 36.)

Lime Sulphur.—About 1851, Grison, at Versailles, France, by boiling lime and sulphur together in water produced a compound known as Eau Grison, which was the forerunner of the lime sulphur spray of to-day. This material appears to have been used for a few seasons and then forgotten, since it was not till 1881 that it again came into prominence, being used in combination with salt in California against the San José scale.

Lime sulphur is prepared to-day by boiling measured quantities of lime and sulphur together in water. The product when filtered is a clear reddish-amber liquid which consists of calcium monosulphide, calcium polysulphides, calcium thiosulphate, and possibly small quantities of calcium sulphate. The amount of these compounds varies according to the method of preparation, the proportions of lime, sulphur, and water used, and the apparatus in which the material has been manufactured. It can be shown that the polysulphides alone possesses fungicidal and insecticidal properties, consequently the worth of the lime sulphur may be measured by the percentage of these ingredients present in solution.

From an insecticidal point of view, lime sulphur is used mainly as a winter insecticide against scale, woolly aphis, and red spider eggs. Its main use is as a fungicide, being applied in the winter against both pome and stone fruit diseases, and also in the summer against brown rot of stone fruits, and various diseases of apples and pears.

Orchard and Garden Notes

By Edward E. Pescott, F.L.S.

The Flower Garden.

DAHLIA growers will find ample work this month. The plants should all have been set in the garden; a stake must be provided for each one, as owing to the brittle character of the stems, they will require support during the windy days of autumn.

The growing plants should be kept well watered, and a good top-dressing of animal manure provided. The top-dressing is important, as it not only keeps the roots cool and provides for plant food, but also assists in tuber formation so very necessary for the young plant.

Plants should receive regular attention to encourage a quick strong growth, which should be tied to the stakes as it increases.

To combat any small insects attacking the plants, spray with nicotine sulphate.

Almost everywhere during the spring just past, largely owing to the abundant rains, Roses made prolific, but in some cases, sappy growth. In many districts, too, the foliage of the plants was severely damaged. Care must be exercised in summer-pruning these plants at the end of January. Only the weak sappy growths, and the old flower heads, should be thinned out.

Seeds of Iceland Poppy, Wallflower, Mignonette, Carnation, Stock, Sweet Pea, Cineraria, and Primula may be sown.

The Orchard.

Regular attention must be given to all forms of combat against Codling Moth. The programme recommended by this Department should be rigidly adhered to. The early sprays of arsenate of lead, and the later sprays of white oil, or both in combination, should be given in their season, and a watch kept for the emergence of broods as shown in the lure pots.

No programme of attack will be complete unless the chemically treated bands of corrugated cardboard are in use.

Cactus Dahlia.

It will be quite unwise for growers to attempt any variation from the recommended official programme, especially in the testing of new sprays.

While it is well known that there are many poisons that will be effective against Codling Moth, it is equally certain that many of these are sure to be dangerous when the fruit is used for human consumption. The use of mercurial compounds should be avoided until these mixtures have been fully analysed and tested by the Departmental chemists.

The Vegetable Garden.

Rapid growth should be induced in the plants of the melon, pumpkin and cucumber family by the free use of manure and water. The terminal and lateral shoots should be pinched at the tips as it is not desirable that they should grow more than 3 feet in length. The pinching checks their growth, and assists in the setting of the fruit.

Lack of pollination is likely to occur in dull or wet weather, owing to the absence of insect visitors. To assist in the setting of the fruit, hand pollination may be resorted to. In any case, this is helpful in increasing the crop. Pollen from a stamen-bearing flower should be brushed on to the fruit-bearing flower, either with a fine brush, or by brushing the flower itself on to the fruiting flower. This latter is readily distinguished by noting the small immature fruit placed immediately below the flower.

Artificial Fertilizers Registered for 1935

Analysis and Unit Values

By Will C. Robertson, Chemist.

THE list of unit values for the years 1934 and 1935 provides one outstanding fact of interest to the man on the land in Victoria—the low unit value for water soluble phosphoric acid—the all-important plant nutrient which is supplied in the form of the cereal and top-dressing fertilizer, superphosphate.

Unit Value.

The unit value of any particular form of nitrogen, phosphoric acid or potash in artificial fertilizers is the commercial value of 1 per cent. in 1 ton of the fertilizer. The values are computed annually by the chemist of the Department of Agriculture from the results of the analyses of the simple fertilizers and the prices per ton set forth in the applications for registration of brands. As the composition of the fertilizer and retail price per ton (within reasonable limits) are in the hands of the manufacturers and importers, it will be readily understood that it is they who actually control unit values, which are commercial and not agricultural values fixed and controlled by the Department of Agriculture.

Table 1.—Comparison of Unit Values.

	Unit Value.				Approximate Percentage.	
	1934.		1935.		Increase.	Decrease.
	s.	*d.*	*s.*	*d.*	%	%
Nitrogen organic—						
As blood, fine bone, &c.	17	7	18	2	3⅓	..
As nitrate ..	17	7	17	7	..	..
As coarse bone ..	15	7	16	0	2⅔	..
As ammonia ..	12	0	12	1	1	..
Phosphoric acid—						
As water soluble ..	4	2	3	6	..	16
As citrate soluble—						
in blood and bone, &c.	4	6	4	3	..	5½
in all other fertilizers ..	3	6	3	4	..	5
As citrate insoluble—						
in blood and bone, &c.	4	0	3	9	..	6
in ground phosphate ..	2	2	2	2	..	..
in other fertilizers ..	1	0	1	0	..	..
As fine bone ..	5	6	5	6	..	..
As coarse bone ..	4	6	4	6	..	..
Potash—						
As sulphate ..	7	8	7	8	..	..
As chloride ..	6	0	6	1	1⅓	..

The unit values for the past and present seasons are compared in Table 1, and show little variation, excepting in the case of superphosphate, and to a lesser extent, in that of the tankage fertilizers, viz., dried blood, blood and bone, &c.

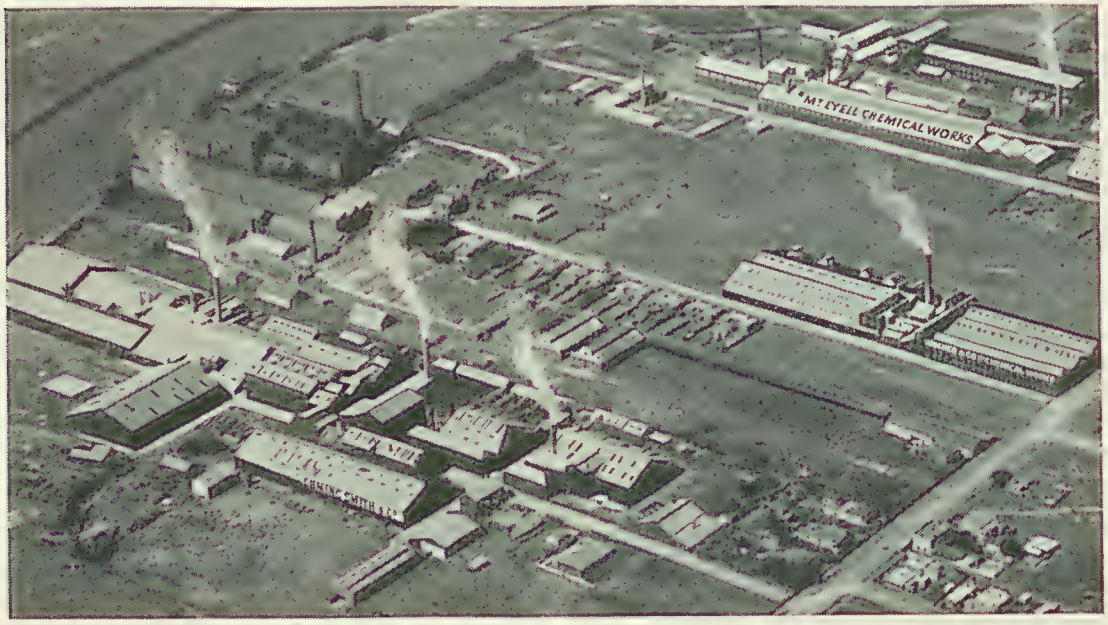
The small increase in the unit value of ammoniacal nitrogen is not worth consideration, and the slight increase in that of potash as chloride may be taken to be due to accident and not to design. There is an appreciable increase in the unit value of nitrogen in organic form in tankage fertilizers, but this is more than accounted for by the decrease in the unit value of the phosphoric acid in this type of fertilizer. The commercial value of these lines is liable to great variation, being dependent on the state of the market, and for this reason it is always advisable, when buying, to compare the values of the various tankage fertilizers and to obtain the latest quotes per ton for two or three of the most satisfactory brands. The fact that the unit value of phosphoric acid in the form of bone is always higher than is the case in the form of superphosphate, irrespective of the former's greater insolubility, is due to many factors of which the main are the greater cost of raw material and the high cost of manufacture, which is governed not only by works efficiency, but also by the tonnage treated.

It must be recognized that comparisons between the unit values of fertilizers of widely different characteristics, such as the chemical and organic, have to be made carefully, for very often they function separately and are used with entirely different objectives.

Phosphatic Fertilizers.

Superphosphate.

The remarkable fall in the unit value of water soluble phosphoric acid, and to a lesser extent, of the other associated phosphoric acid units,



A general view of local artificial fertilizer works.

will be of particular benefit to the producer. This season's fall in the price per ton of superphosphate means that the Victorian farmer is using superphosphate of the highest quality and lowest price in the world.

Although several factors probably co-operated to bring about this desirable result, the main reasons for the pronounced reduction in the price of superphosphate are said to be :—

1. Reduction in the price of raw material.
2. Increase in efficiency at the works due to intensive research and vast improvement in method.
3. Reduction in agents' commission (in some instances agencies have been dispensed with altogether).
4. Reduction in credit system, with the consequent decrease in the bad debt risk.
5. Elimination of works duplication or spread by the amalgamation of existing companies or by the installation of new plant on the co-operative system.
6. Increased cash trade.
7. Increase in the quality of the raw material reducing the waste of acid.

The quality of superphosphate in Victoria, viz. :—22 per cent. (20·5 per cent. water soluble) is of a very high standard and compares more than favorably with the 14 per cent. article on the markets overseas, where little notice is taken of the phosphoric acid content of superphosphate apart from that which is soluble in water. It does not follow that the vast difference in the quality of the two superphosphates (Victorian and Continental) denotes adulteration in the article abroad. The difference in quality is entirely due to the grade of rock phosphate used in the manufacture, that used in English, Continental, and American factories being much inferior to the high-grade phosphate procurable at Nauru, Ocean and Christmas Islands, and used in the Australian trade.

Although about 90 per cent. of the total annual tonnage of artificial fertilizer which is used in Victoria consists of superphosphate it is interesting to note the numerous brands registered for fertilizers of widely different composition. One would assume in view of the renowned phosphate deficiency in Victorian soils and the persistent demand for superphosphate that the limited tonnage of other fertilizers in demand would be insufficient to encourage capital expenditure on the plants required. Fortunately various artificial fertilizers are produced as by-products, and consequently the costs of plant and factory are discounted by the nominal or decreased cost of raw material.

Nitrogenous Fertilizers.

Sulphate of Ammonia.

As superphosphate is the fertilizer, *par excellence*, for the supply of water soluble phosphoric acid

so does sulphate of ammonia hold a similar position with the farming community in so far as water soluble readily available nitrogen is concerned. This fertilizer is a by-product of the gas industry in Victoria. During destructive distillation the nitrogen content of coal is recovered as ammoniacal liquor, which, after treatment with sulphuric acid, is concentrated by evaporation to the point of crystallization, and the crystals of sulphate of ammonia recovered. Slight alteration in the method of neutralizing the liquor and drying the crystals produces what is termed neutral ammonium sulphate which can be identified by its appearance—clean white granular crystals, not unlike beet sugar, and totally different from the acid sulphate, the crystals of which are always of a more or less pronounced green or blue-green tinge, and which have the annoying habit of segregating into hard lumps. In the face of the fact that both forms of the fertilizer, i.e., acid and neutral, are entirely similar as regards their content of nitrogen, viz., between 20 and 21 per cent., and are listed at the same price—the incessant demand for the old original acid sulphate by the practical intense culturist, who is the main user of the fertilizer, requires explanation. Possibly there is an unconscious bias in favour of the old and tried fertilizer which has always been readily recognized by the more or less pronounced green colour as opposed to the white sugary crystals of the more recently improved form of neutral sulphate, though it may be that the small amount of impurity in the acid sulphate has a fungicidal or insecticidal action which is not present in the neutral sulphate.

A score of years ago the output of sulphate of ammonia was largely in excess of the demand, with the result that the bulk of the tonnage produced was exported. In those days the value of the fertilizer was little understood and the high price per ton retarded experimentation on the part of those whose farming operations appeared to require more than the orthodox programme of manuring with superphosphate. In recent years intensive propaganda, associated with a large reduction in the price, has revolutionized the sulphate of ammonia trade, until to-day the Victorian requirements are in excess of the supply, necessitating the importation of an appreciable tonnage from abroad. A large proportion of the world's requirements in this fertilizer are now being met by its synthetic manufacture from the nitrogen of air by electrical means.

Unlike superphosphate, which is so extensively used by the wheat farmer and grazier, sulphate of ammonia has little or nothing to do with the production of wheat and wool, but is used by the orchardist, market gardener, potato grower, and specialist farmer. A glance at the list of registered brands, appended, shows the importance of the fertilizer in the manufacture of mixed or complete manures.

Nitrate of Soda.

Nitrate of soda, commonly known as Chilean saltpetre, is not largely used as a fertilizer in Victoria. In isolated instances small lots of the manure are used by market gardeners to force certain crops, such as tomatoes and lettuce. The fertilizer occurs as a natural deposit in the rainless region of Chile. In recent years its physical condition has been vastly improved, but although the value of nitrate of soda as a readily soluble, quick-acting nitrogenous fertilizer is well-known, the high unit value of 17s. 7d., when compared with that of sulphate of ammonia at 12s. 1d., even assuming some superiority on the part of the nitrate, is probably the main factor which limits its general use.

Nitro Chalk.

Although nitro chalk, for some years, has enjoyed great popularity as a useful special nitrogenous fertilizer in various parts of the world, more particularly in Great Britain and on the continent, it has not yet established itself on the Victorian market. Nitro chalk is a quick-acting nitrogenous fertilizer, containing 15·5 per cent. of nitrogen, of which one-half is in the form of nitrate and the remaining half in the form of ammonia. Nitro chalk is a mixture of ammonium nitrate and chalk, a blend of nitrogen with lime which possesses distinct possibilities when applied to certain soils under intense culture. The fertilizer is an imported line, and when it becomes more generally known it is possible that the tonnage used annually will increase to an appreciable amount.

Dried Blood and Blood Manure.

Dried blood and blood manure are the main suppliers of organic nitrogen in concentrated form. The former is, as the name implies, blood (animal) which has been coagulated and dried by artificial means. It differs from blood manure in that whereas the latter contains offal as well as blood the former is prepared from the clean blood uncontaminated with any foreign substance. Dried blood, therefore, contains a greater percentage of nitrogen than blood manure. Both contain small amounts of phosphoric acid and potash, both in readily available form although not guaranteed as such, if at all. These manures

may, therefore, be regarded as complete fertilizers in miniature.

Nitrogen as blood, while not so readily available as nitrate or ammoniacal nitrogen, breaks down through bacterial activity in the soil when conditions are suitable and nitrifies at such a rate that the whole of its nitrogen content is converted into the available form in the course of two or three months. Owing to slower availability, these fertilizers are often preferred by market gardeners when seeking slow and even growth in opposition to the forcing tactics employed when using nitrate or ammoniacal nitrogen.

The use of blood manure is fairly general throughout the State, the higher grade article, viz. :—dried blood, being rarely used excepting for blending. The demand for this class of substance as a protein food for poultry has had an effect on its use as a fertilizer. Purchasers of dried blood and blood manure should know that they provide the soil with humus as well as plant food. The amount might be small and will depend upon the quantity of fertilizer applied per acre, but over a period of years the improvement in soil texture might be noticeable. In any case the blood manures supply humus while the other concentrated nitrogenous fertilizers listed, which are of mineral origin, contain no appreciable amount of organic matter and, therefore, do not replenish the soil in this respect.

Castor Meal.

Castor meal is the finely ground refuse of the castor bean after the extraction of the castor oil. Its value depends on its nitrogen content, which is very slow acting and too close to the ammonia unit in price to receive much consideration.

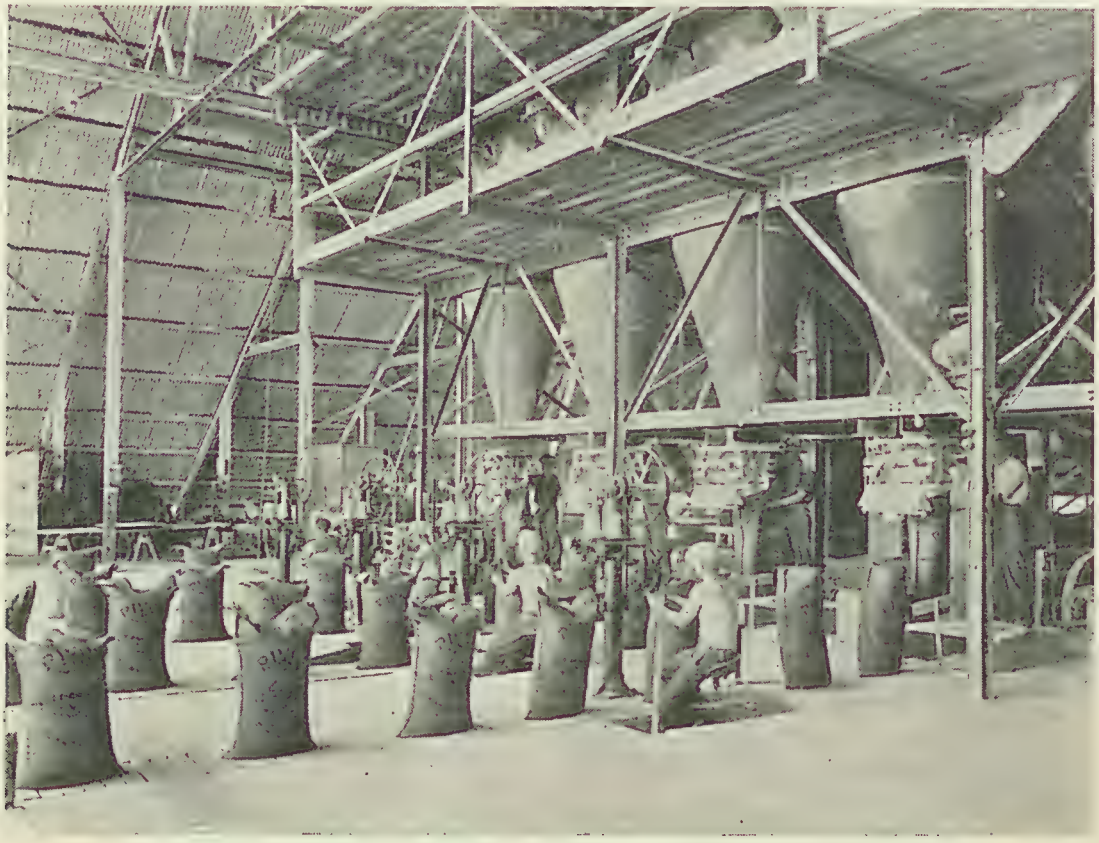
Potassic Fertilizers.

Muriate of Potash.

Muriate of potash or potassium chloride occurs as a natural deposit in certain parts of the world, particularly in Germany and France. Potash salts, when mined, are of several grades, and the muriate placed on the Victorian market is of medium quality.

Sulphate of Potash.

The sulphate is the dearer form of potash and is prepared by treating the muriate with sulphuric



Bagging and weighing fertilizer at the works. Note the floor conveyors.

acid, which is one reason for the higher unit value. The sulphate form of potash is in greater favour than the muriate for all purposes, and this fact may have a little influence in determining the marked difference between the unit values of potash in the two forms.

The amount of potash fertilizers used in Victoria in the simple condition is very small, but owing to their use in admixture with other fertilizers in the preparation of mixed and complete fertilizers the tonnage imported is appreciable.

Other Fertilizers.

Space does not permit of a review of the remaining brands of fertilizers registered and on the Victorian market. Generally speaking they are special mixtures of long standing which have been well tried by many practical farmers in various districts, and as a result have been considered worthy of a repeat order until finally the demand became sufficiently persistent and extensive to warrant the registration of a brand.

Organic fertilizers of the tankage type, such as blood and bone, animal fertilizers, and bonedusts, are sufficiently interesting to demand reviewing at length, and it is proposed to do this at a later date.

Prices at Home and Abroad.

In Table 2, a comparison is given of the prices of the principal fertilizers in Victoria and in London.

The figures in the table speak for themselves, and with the exception of our main fertilizers, i.e., superphosphate, blood and bone, and bone dust, local prices are practically double the prices charged the English farmer.

The 14 per cent. grade of superphosphate on the English market, when computed by the unit value system in comparison with the high grade Victorian 22 per cent. superphosphate, is a slightly dearer proposition.

Table 2.—Fertilizer Prices.

Fertilizer.	London Price per Ton.	Victorian Price per Ton.
	£ s. d.	£ s. d.
Nitrate of soda	7 12 6	13 10 0
Sulphate of ammonia ..	6 19 0	12 7 0
Nitro chalk	7 5 0	12 8 6
Superphosphate	2 12 6 (14%)	3 15 0 (20·5%)
Muriate of potash	6 16 0	15 7 0
Sulphate of potash	7 18 6	18 10 0
Bonedust (3·75/20·5) ..	6 10 0	7 0 0 (average)
Meat and bone meal, equivalent to blood and bone (6 and 14 per cent.)	6 10 0	7 10 0 (average)

How to Calculate the Commercial Value of a Fertilizer.

Dried Blood.

Analysis—		£ s. d.
Nitrogen as blood 11·50 per cent.		
then—		
Percentage of fertilizing constituent @ its unit value =		
11·50 @ 18s. 2d.		=10 9 0
Calculated value per ton ..		=10 9 0
Price asked per ton ..		= 9.10 0

The computation in this instance proved to be well worth while, because the calculated commercial value is 19s. higher than the price asked per ton. When instances of this description occur it is always advisable to calculate the commercial value of all the brands of this particular type of fertilizer in the list and then seek quotes per ton for the fertilizer.

Complete Manure.

Analysis—			£ s. d.
Nitrogen as ammonia ..	9.10	per cent.	
Phosphoric acid as—			
Water soluble	9·10	,,	
Citrate soluble	·20	,,	
Citrate insoluble ..	·40	,,	
Potash as sulphate ..	5·30	,,	
then—			
Percentage fertilizing constituent @ the unit value=			
9·10 Nitrogen as ammonia @ 12s. 1d.			= 5 10 0
9·10 Phosphoric acid as water soluble @ 3s. 6d.			= 1 11 10
·20 Phosphoric acid as citrate soluble @ 3s. 4d. ..			= 0 0 8
·40 Phosphoric acid as citrate insoluble @ 2s. 2d. ..			= 0 0 10
5·30 Potash as sulphate @ 7s. 8d.			= 2 0 7
Calculated value per ton ..			9 3 11
Price asked per ton ..			9 17 6

The calculated commercial value of this brand is approximately 13s. per ton lower than the price asked, but out of this amount the manufacturer has to pay for the extra cost of handling and mixing so that the price of this complete manure when calculated on the unit value system may be taken as reasonable.

Fertilizers Act 1928 (No. 3680).

LIST OF UNIT VALUES FOR 1935.

	£	s.	d.
Nitrogen, organic, as Blood; Blood and Bone; Blood, Bone, and Flesh; and Fine Bone	0	18	2
„ as Nitrate	0	17	7
„ as Coarse Bone and in Bone Fertilizers	0	16	0
„ as Ammonia	0	12	1
Phosphoric Acid—			
as Water Soluble	0	3	6
as Citrate Soluble—			
in Blood and Bone, in Animal Fertilizers, and in Mixed and Complete Fertilizers containing either or both of the foregoing	0	4	3
in all other Fertilizers	0	3	4
as Citrate Insoluble—			
in Blood and Bone, in Animal Fertilizers and in Mixed and Complete Fertilizers containing either or both of the foregoing	0	3	9
in other Mixed Fertilizers and in Ground Phosphate	0	2	2
in other Fertilizers	0	1	0
as Fine Bone	0	5	6
as Coarse Bone	0	4	6
Potash, as Sulphate	0	7	8
„ as Chloride	0	6	1

W. R. JEWELL, M.Sc., F.I.C.,
Chemist for Agriculture.

Melbourne, 1st December, 1934.

LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1928 (No. 3680) FOR THE YEAR 1935.

Description of Fertilizer.	Brand.	Nitrogen.						Phosphoric Acid.				Potash as Sulphate.	Price asked per ton.*			Where Obtainable.
		As Nitrate.	As Ammonia.	As Blood.	As Blood and Bone.	As Blood, Bone, and Flesh.	Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	Total.		£	s.	d.	
Nitrogenous— Readily Soluble.		%	%	%	%	%	%	%	%	%	%	%				
Nitrate of Soda	Cresco	15·00	..	..	..	..	15·00	..	..	..	..	..	13	10	0	Cresco Fertilizers Ltd., Geelong
„ „	Pivot	15·50	..	..	..	..	15·50	..	..	..	..	..	13	10	0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond	15·50	..	..	..	..	15·50	..	..	..	..	..	13	10	0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Sulphate of Ammonia	M.G. Co. in diamond	..	20·59	..	..	..	20·59	..	..	..	..	..	12	2	4	Metropolitan Gas Co., 196 Flinders-st., Melbourne
„ „	Cresco	..	20·00	..	..	..	20·00	..	..	..	..	..	12	8	6	Cresco Fertilizers Ltd., Geelong
„ „	Pivot	..	20·60	..	..	..	20·60	..	..	..	..	..	12	8	6	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond	..	20·60	..	..	..	20·60	..	..	..	..	..	12	8	6	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Nitro Chalk	Sickle in diamond	7·75	7·75	..	..	..	15·50	..	..	..	..	..	12	8	6	„ „ „
Moderately Soluble.																
Dried Blood	Imperial in diamond	..	..	11·75	..	..	11·75	..	..	0·75	0·75	0·50	9	10	0	W. Angliss and Co. (Aust.) Pty. Ltd., 42 Bourke-st. Melbourne
„ „	M.C.C. in diamond	..	..	11·50	..	..	11·50	..	..	..	..	..	9	10	0	Melbourne City Abattoirs, Smithfield-rd., Flemington, W.1
„ „	Pannifex	..	..	12·00	..	..	12·00	..	..	0·50	0·50	1·10	11	0	0	H. C. Pannifex and Co., 401 Flinders-st., Melbourne
„ „	T.B. & S. in diamond— Brooklyn	..	..	11·60	..	..	11·60	..	..	..	..	..	10	0	0	Thos. Borthwick and Sons (A/asia) Ltd., 84 William-st., Melbourne

LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1928 (No. 3680) FOR THE YEAR 1935—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.						Phosphoric Acid.				Potash as Sulphate.	Price asked per ton.*	Where Obtainable.
		As Nitrate.	As Ammonia.	As Blood.	As Blood and Bone.	As Blood, Bone, and Flesh.	Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	Total.			
Nitrogenous—Moderately Soluble—contd.		%	%	%	%	%	%	%	%	%	%	%	£ s. d.	
Blood Manure ..	Cockbill's ..	..	..	8·50	..	..	8·50	..	..	1·00	1·00	..	9 10 0	W. and J. Cockbill (trading as J. Cockbill), 407 Post Office-place, Melbourne
„ „ ..	M.C.C. in diamond	..	..	8·00	..	..	8·00	..	..	..	..	..	6 15 0	Melbourne City Abattoirs, Smithfield-rd., Flemington, W.1
„ „ ..	Nifex ..	..	..	7·50	..	..	7·50	..	..	1·00	1·00	0·25	7 15 0	H. C. Pannifex and Co., 401 Flinders-st., Melbourne
„ „ ..	Sickle in diamond	..	..	7·50	..	..	7·50	..	..	..	..	..	8 10 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Slowly Soluble. Castor Meal ..	Alba ..	..	..	..	..	..	5·00 (as castor meal)	..	..	2·25	2·25	0·75	3 15 0	Lycett Pty. Ltd., Normanby-rd., Montague
Phosphatic—Readily Soluble. Superphosphate 22 per cent.	Cockbill's ..	..	..	..	..	..	..	20·50	0·50	1·00	22·00	..	3 15 0	W. and J. Cockbill (trading as J. Cockbill), 407 Post Office-place, Melbourne
„ „	Cresco ..	..	..	..	..	..	..	20·50	0·50	1·00	22·00	..	3 15 0	Cresco Fertilizers Ltd., Geelong
„ „	Lamaco ..	..	..	..	..	..	..	20·50	0·50	1·00	22·00	..	3 15 0	New Zealand Loan and Mercantile Agency Co. Ltd., 538 Collins-st., Melbourne
„ „	Pivot ..	..	..	..	..	..	..	20·50	0·50	1·00	22·00	..	3 15 0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond	..	..	..	..	..	..	20·50	0·50	1·00	22·00	..	3 15 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Phosphatic—Moderately Soluble. Basic Phosphate	Pivot ..	..	..	..	..	..	..	..	15·50	3·00	18·50	..	4 15 0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond	..	..	..	..	..	..	..	15·50	3·20	18·70	..	4 15 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Super. and Rock Phosphate	Cresco 50/50 ..	..	..	..	..	..	..	9·16	1·84	17·40	28·40	..	4 5 0	Cresco Fertilizers Ltd., Geelong
„ „	Pivot ..	..	..	..	..	..	..	10·00	0·50	18·50	29·00	..	4 5 0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond	..	..	..	..	..	..	10·00	0·50	18·50	29·00	..	4 5 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Slowly Soluble. Ground Phosphate	Pivot ..	..	..	..	..	..	..	..	..	36·50	36·50	..	3 15 0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Pivot, very fine	..	..	..	..	..	..	..	..	36·50	36·50	..	4 0 0	„ „ „
„ „	Sickle in diamond (80%)	..	..	..	..	..	..	..	..	36·65	36·65	..	4 0 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Potassic—Readily Soluble. Muriate of Potash	Cresco ..	..	..	..	..	..	..	..	..	..	..	50·00 (as chloride)	15 10 0	Cresco Fertilizers Ltd., Geelong
„ „	Sickle in diamond (80%)	..	..	..	..	..	..	..	..	..	..	50·00 (as chloride)	15 10 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne

LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1928 (No. 3680) FOR THE YEAR 1935—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.						Phosphoric Acid.				Potash as Sulphate.	Price asked per ton.*			Where Obtainable.
		As Nitrate.	As Ammonia.	As Blood.	As Blood and Bone.	As Blood, Bone, and Flesh.	Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	Total.		£	s.	d.	
Potassic—Readily Soluble—continued.		%	%	%	%	%	%	%	%	%	%	%				
Muriate of Potash	Unity ..	..	..	..	..	..	..	..	..	..	..	51·00 (as chloride)	15	0	0	T. E. Butler, 358 Collins-st., Melbourne
Sulphate of Potash	Cresco ..	..	..	..	..	..	..	..	..	..	..	48·50	18	10	0	Cresco Fertilizers Ltd., Geelong
„ „	Pivot ..	..	..	..	..	..	..	..	..	..	..	48·50	18	10	0	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Sickle in diamond (90%)	..	..	..	..	..	..	..	..	..	..	48·50	18	10	0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Containing Nitrogen and Phosphoric Acid—Readily Soluble.																
Super. and Ammonia	Cresco (6 and 1)	..	2·85	..	..	..	2·85	17·48	0·42	0·85	18·75	..	5	12	6	Cresco Fertilizers Ltd., Geelong
„ „	Cresco (3 and 1)	..	5·00	..	..	..	5·00	15·37	..	1·13	16·50	..	6	10	0	„ „ „
„ „	Cresco (2 and 1)	..	6·87	..	..	..	6·87	13·66	0·34	0·66	14·66	..	7	5	0	„ „ „
„ „	Cresco (1 and 1)	..	10·30	..	..	..	10·30	10·25	0·25	0·50	11·00	..	8	12	6	„ „ „
„ „	Pivot I. ..	..	2·90	..	..	..	2·90	17·40	0·40	0·80	18·60	..	5	12	6	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
„ „	Pivot II. ..	..	5·00	..	..	..	5·00	15·30	0·30	0·80	16·40	..	6	10	0	„ „ „
„ „	Pivot II. (*a*) ..	..	6·80	..	..	..	6·80	13·60	0·30	0·60	14·60	..	7	5	0	„ „ „
„ „	Pivot III. ..	..	10·00	..	..	..	10·00	10·20	0·20	0·50	10·90	..	8	12	6	„ „ „
„ „	Sickle in diamond (6 to 1)	..	2·90	..	..	..	2·90	17·57	0·43	0·85	18·85	..	5	12	6	„ „ „
„ „	Sickle in diamond (3 to 1)	..	5·05	..	..	..	5·05	15·37	0·37	0·76	16·50	..	6	10	0	„ „ „
„ „	Sickle in diamond (2 to 1)	..	6·87	..	..	..	6·87	13·66	0·34	0·66	14·66	..	7	5	0	„ „ „
„ „	Sickle in diamond (1 to 1)	..	10·30	..	..	..	10·30	10·25	0·25	0·50	11·00	..	8	12	6	„ „ „
Nitro - Superphosphate	Cresco ..	..	1·50	..	0·50	..	2·00	16·39	1·10	1·70	19·19	..	6	5	0	Cresco Fertilizers Ltd., Geelong
„ „	Sickle in diamond	..	1·50	..	..	0·50	2·00	16·69	1·12	2·01	19·82	..	6	5	0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Moderately Soluble.																
Ammonia and Rock Phosphate	Cresco ..	..	2·00	..	..	..	2·00	8·30	1·60	15·70	25·60	..	5	7	6	Cresco Fertilizers Ltd., Geelong
Blood, Bone, and Super.	Cockbill's ..	..	..	..	2·50	..	2·50	12·51	1·43	2·96	16·90	..	7	10	0	W. and J. Cockbill (trading as J. Cockbill), 407 Post Office-place, Melbourne
„ „	Sickle in diamond	..	..	..	..	2·50	2·50	12·51	1·43	2·96	16·90	..	6	10	0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Bone and Super.	Cresco ..	..	..	..	2·00	..	2·00	9·50	3·90	3·00	16·40	..	6	10	0	Cresco Fertilizers Ltd., Geelong
„ „	J. A. Dundas..	..	..	..	..	2·25	2·25	9·99	5·16	5·58	20·73	..	7	0	0	J. A. Dundas, Dynon-rd., Footscray
„ „	Sickle in diamond, No. 1	..	..	..	..	2·00	2·00	11·38	3·08	5·32	19·78	..	6	10	0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Bone Fertilizer and Super.	Elsworth's ..	..	..	..	..	..	1·50 (as bone)	11·00	2·50	5·00	18·50	..	6	5	0	W. R. Elsworth, York-st., Ballarat
Super. and Bone	Cresco ..	..	..	..	..	1·00	1·00	16·10	1·10	3·60	20·80	..	5	17	6	Cresco Fertilizers Ltd., Geelong
„ „	Sickle in diamond, No. 2	..	..	..	..	1·00	1·00	15·95	1·79	3·16	20·90	..	5	17	6	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Blood and Bone	Apollo ..	..	..	..	5·00	..	5·00	..	4·00	12·00	16·00	..	8	0	0	J. Kitchen and Sons Pty. Ltd., Ingles-st., Port Melbourne

LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1928 (No. 3630) FOR THE YEAR 1935—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.						Phosphoric Acid.				Potash as Sulphate.	Price asked per ton.*	Where Obtainable.
		As Nitrate.	As Ammonia.	As Blood.	As Blood and Bone.	As Blood, Bone, and Flesh.	Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	Total.			
Containing Nitrogen and Phosphoric Acid—Moderately Soluble—continued.		%	%	%	%	%	%	%	%	%	%	%	£ s. d.	
Blood and Bone	Arch No. 1 ..	..	..	..	7·00	..	7·00	..	5·00	5·00	10·00	..	8 0 0	Amalgamated Freezing Co. (Vict.) Pty. Ltd., 54 Market-st., Melbourne
„ „	Clover ..	..	..	..	4·76	..	4·76	..	9·81	6·17	15·98	..	7 0 0	H. T. Impey, 139 Barkly-st., Ararat
„ „	Cockbill's ..	..	..	..	..	5·25	5·25	..	3·00	9·00	12·00	..	8 10 0	W. and J. Cockbill (trading as J. Cockbill), 407 Post Office-place, Melbourne
„ „	Corio ..	..	..	..	4·00	..	4·00	..	6·00	8·00	14·00	..	6 10 0	The Corio Trading Co. Pty. Ltd., 164 Moorabool-st., Geelong
„ „	Cresco ..	..	..	..	..	5·00	5·00	..	3·00	11·50	14·50	..	7 10 0	Cresco Fertilizers Ltd., Geelong
„ „	Fitzgerald's ..	..	..	..	5·50	..	5·50	..	6·05	8·10	14·15	..	7 0 0	P. Fitzgerald and Sons, Warrigal-rd., Oakleigh
„ „	Imperial in diamond	..	..	..	..	5·00	5·00	..	5·00	10·00	15·00	..	6 10 0	W. Angliss and Co. (Aust.) Pty. Ltd., 42 Bourke-st., Melbourne
„ „	J. A. Dundas..	..	..	..	..	4·50	4·50	..	7·14	13·61	20·75	..	8 0 0	J. A. Dundas, Dynon-rd., Footscray
„ „	Pannifex's No. 1	..	..	..	..	6·35	6·35	..	5·00	6·50	11·50	..	8 15 0	H. C. Pannifex and Co., 401 Flinders-st., Melbourne
„ „	Pannifex's No. 2	..	..	..	..	7·17	7·17	..	5·00	6·99	11·99	..	9 0 0	„ „ „
„ „	Pannifex's No. 5	..	..	..	..	8·00	8·00	..	3·00	5·00	8·00	..	8 10 0	„ „ „
„ „	Pannifex's Oak	..	..	..	..	6·90	6·90	..	4·00	5·50	9·50	..	8 10 0	„ „ „
„ „	Pridham's ..	..	..	..	5·40	..	5·40	..	8·50	5·50	14·00	..	6 10 0	W. Pridham Pty. Ltd., Evans-st., Braybrook
„ „	Sickle in diamond	..	..	..	..	5·00	5·00	..	6·00	10·00	16·00	..	7 10 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
„ „	T.B. & S. in diamond—Brooklyn	..	..	..	6·00	..	6·00	..	6·00	6·00	12·00	..	7 10 0	Thos. Borthwick and Sons (A/sia) Ltd., 84 William-st., Melbourne
„ „	T.B. & S. in diamond—Lighthouse	..	..	..	6·00	..	6·00	..	5·00	2·00	7·00	..	7 10 0	„ „ „
„ „	Tongala ..	..	..	..	..	4·36	4·36	..	6·25	6·84	13·09	..	7 0 0	Russell and Son, Tongala
„ „	W. & M. in circle	..	..	..	5·00	..	5·00	..	4·50	7·50	12·00	..	8 10 0	Western and Murray Co-operative Bacon Co. Ltd., 522 Flinders-lane, Melbourne
Animal Fertilizer	Fertillo ..	..	..	..	..	6·00	6·00	..	6·00	9·00	15·00	..	8 15 0	Glues and By-Products Pty. Ltd., 86 King-st., Melbourne
„ „	Fitzgerald's ..	..	..	..	..	3·50	3·50	..	6·75	11·25	18·00	..	7 0 0	P. Fitzgerald and Sons, Warrigal-rd., Oakleigh
„ „	Ibis	..	..	..	..	4·00	4·00	..	7·90	8·10	16·00	..	6 12 6	Ficken, Haliday, and McClelland Pty. Ltd., Raleigh-st., Braybrook
„ „	Pannifex's No. 2	..	..	..	..	4·50	4·50	..	5·00	12·00	17·00	..	7 15 0	H. C. Pannifex and Co., 401 Flinders-st., Melbourne
„ „	Pannifex's No. 3	..	..	..	..	5·50	5·50	..	5·00	10·00	15·00	..	8 0 0	„ „ „
„ „	Pannifex's No. 4	..	..	..	..	6·00	6·00	..	5·00	7·00	12·00	..	8 15 0	„ „ „
„ „	Pannifex's No. 5	..	..	..	..	3·00	3·00	..	5·00	12·00	17·00	..	7 0 0	„ „ „
„ „	Pannifex's No. 6	..	..	..	..	6·00	6·00	..	6·00	10·00	16·00	..	7 10 0	„ „ „
„ „	Pannifex's No. 7	..	..	..	..	4·00	4·00	..	7·00	9·00	16·00	..	6 15 0	„ „ „
„ „	Pannifex's No. 8	..	..	..	..	4·75	4·75	..	6·50	12·50	19·00	..	7 10 0	„ „ „
„ „	Fertbone ..	..	..	..	..	5·00	5·00	..	4·00	8·00	12·00	..	7 10 0	„ „ „
Bone Fertilizer	Elsworth's ..	..	..	..	..	..	4·00 (as bone)	0·50	5·80	11·70	18·00	..	6 10 0	W. R. Elsworth, York-st., Ballarat
„ „	Pannifex's ..	..	..	..	..	..	4·00 (as bone)	0·50	5·80	11·70	18·00	..	6 15 0	H. C. Pannifex and Co., 401 Flinders-st., Melbourne
Mixed Manure ..	Humo-phos. ..	..	1·28	1·03 (as organic)	..	..	2·31	..	..	5·46	5·46	..	4 0 0	Peninsula Lime and Fertilizer Co. Pty. Ltd., 70 Elizabeth-st., Melbourne

LIST OF FERTILIZERS REGISTERED AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE UNDER THE FERTILIZERS ACT 1928 (No. 3680) FOR THE YEAR 1935—*continued.*

Description of Fertilizer.	Brand.	Nitrogen.						Phosphoric Acid.				Potash as Sulphate.	Price asked per ton.*	Where Obtainable.
		As Nitrate.	As Ammonia.	As Blood.	As Blood and Bone.	As Blood, Bone, and Flesh.	Total.	As Water Soluble.	As Citrate Soluble.	As Citrate Insoluble.	Total.			
Containing Nitrogen, Phosphoric Acid, and Potash.		%	%	%	%	%	%	%	%	%	%	%	£ s. d.	
Market Garden Manure	Cresco ..	..	1·50	..	1·56	..	3·06	11·65	1·49	3·26	16·40	2·42	7 15 0	Cresco Fertilizers Ltd., Geelong
,, ,,	Sickle in diamond	..	1·72	..	..	1·56	3·28	10·26	2·43	4·23	16·92	2·42	7 15 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
Complete Manure	Pivot IV. ..	..	2·90	..	..	..	2·90	14·30	0·30	0·70	15·30	6·90	7 12 6	The Phosphate Co-operative Co. of Aust. Ltd., 447 Little Collins-st., Melbourne
,, ,,	Pivot V. ..	..	8·20	..	..	..	8·20	8·20	0·20	0·40	8·80	9·60	10 0 0	,, ,, ,,
,, ,,	Pivot VI ..	..	9·10	..	..	..	9·10	9·10	0·20	0·40	9·70	5·30	9 17 6	,, ,, ,,
,, ,,	Sickle in diamond, No. 1	..	1·00	..	..	1·40	2·40	10·94	2·22	3·86	17·02	5·00 (as chloride)	7 10 0	Commonwealth Fertilizers and Chemicals Ltd., 65 William-st., Melbourne
,, ,,	Sickle in diamond, No. 2	..	1·00	..	..	1·00	2·00	14·85	0·36	0·72	15·93	4·85	7 7 6	,, ,, ,,
,, ,,	Sickle in diamond— (A. 5 : 1 : 1)	..	2·90	..	..	..	2·90	14·64	0·36	0·71	15·71	6·90	7 12 6	,, ,, ,,
,, ,,	Sickle in diamond— (B. 5 : 2 : 1)	..	5·05	..	..	..	5·05	12·81	0·31	0·63	13·75	6·06	8 12 6	,, ,, ,,
,, ,,	Sickle in diamond— (C. 4 : 4 : 1)	..	9·15	..	..	..	9·15	9·11	0·22	0·44	9·77	5·39	9 17 6	,, ,, ,,
,, ,,	Sickle in diamond— (D. 2 : 2 : 1)	..	8·24	..	..	..	8·24	8·20	0·20	0·40	8·80	10·00 (as chloride)	10 0 0	,, ,, ,,
Mixed Manure..	Cresco No. 2..	..	1·00	..	1·40	..	2·40	11·25	2·00	4·50	17·75	5·00	8 0 0	Cresco Fertilizers Ltd., Geelong
,, ,, ..	Cresco No. 3 ..	..	9·15	..	..	..	9·15	9·11	0·22	0·44	9·77	5·39	9 17 6	,, ,, ,,
,, ,, ..	Cresco No. 4 ..	..	2·57	..	..	..	2·57	15·37	0·38	0·75	16·50	6·06	7 12 6	,, ,, ,,
,, ,, ..	Cresco No. 5 ..	..	8·24	..	..	..	8·24	8·20	0·20	0·40	8·80	10·00 (as chloride)	10 0 0	,, ,, ,,

Description of Fertilizer.	Brand.	Nitrogen.	Phosphoric Acid.	Mechanical Condition.		Price asked per ton.*	Where Obtainable.
				Fine Bone.	Coarse Bone.		
		%	%	%	%	£ s. d.	
Bonedust ..	Apex ..	3·25	22·00	50	50	7 10 0	North-Eastern Bone Products, Bowser, Victoria
,, ..	Mount Clear ..	3·00	19·00	50	50	7 0 0	Bailey Bros., 6 Sturt-street, Ballarat
,, ..	Rohs in circle..	4·00	19·00	50	50	7 15 0	P. Rohs Pty. Ltd., Bridge-street, Bendigo
,, ..	Nuelife ..	3·50	23·50	50	50	8 0 0	E. F. Peters and Sons Pty. Ltd., Dunolly
,, ..	Pioneer ..	3·82	21·96	50	50	8 0 0	W. A. Rainey, Mepunga East, via Allansford
,, ..	Oak	2·00	24·00	70	30	10 0 0	H. C. Pannifex and Co., 401 Flinders-street, Melbourne
,, ..	Pannifex's No. 2	4·00	19·00	50	50	9 0 0	,, ,, ,, ,, ,, ,,
,, ..	"B" ..	3·25	23·20	50	50	6 10 0	T. Benson, Woodford

* F.O.R. at station nearest place of manufacture or, when imported, Melbourne.

W. R. JEWELL, M.Sc., F.I.C.,
Chemist for Agriculture.

Melbourne, 1st December, 1934.

SUMMER SPRAYING

SHELL SPRAYING OILS

Growers who are preparing now to safeguard the new crop against codlin attacks, are advised to include only the highest quality white oil in their cover sprays.

Use Shell Whitespray — the white oil which found lasting favour with many growers last season.

The Shell Company Limited

S0.62

For AUSTRALIAN FARMERS!

"WARATAH" WIRE NETTING

"WARATAH" FENCING WIRE

"WARATAH" STAR STEEL FENCE POSTS

"WARATAH" HINGED-JOINT FENCE

100 % Australian from the Iron Ore to the Fence.

Specify "Waratah," and see that you get it.
Rylands Stand Behind Their Products.

Made by

RYLANDS BROS. (Aust.) Ltd.

Head Office : 422 Little Collins St., Melbourne

Phone C.7870 *Works :* Newcastle, N.S.W.

DEPARTMENT OF AGRICULTURE, VICTORIA

Price
8d.
Posted.

A Second Edition of this useful publication
IS NOW ON SALE!

THE SHEEP INDUSTRY

A PROFUSELY illustrated publication dealing with Sheep-raising, also Sheep Diseases and their treatment.

METHODS of countering the attack of the sheep blowfly are outlined in detail. Other chapters deal with the selection of ewes and rams, classing the clip, baling and pressing wool, and the raising of fat lambs. Plans and specifications for the construction of a sheep-dip, shearing sheds, drafting yards, self-feeders, and a home-made wool press are included.

The publication contains 84 pages of reading matter and many photographs.

Obtainable from the DIRECTOR, Department of Agriculture, Melbourne, C.2.

Just Published

Price 1/9
(including postage)

A NEW EDITION of "Beekeeping in Victoria," a comprehensive book in which beekeeping practices are fully described, has been published by the Department of Agriculture.

This publication, which contains 165 pages, is well illustrated, and should be of interest not only to commercial apiarists, but also to those who desire to carry on bee culture as a hobby or side-line to other occupations.

Obtainable from

The Director,
Department of Agriculture,
Melbourne, C.2

LYSAGHT'S

100 % Australian Made 100 %

Fencing and Other Wires, Wire Netting, Zinc Oxide

Our Netting and Other Products are known through the Commonwealth as of the highest standard. Obtainable from all leading Merchants and Storekeepers.

LYSAGHT'S AUSTRALIAN MADE WIRE NETTING SYDNEY N.S.W. PROOF REG. TRADE MARK

Look for Our Marker in Every Roll of Netting

Manufactured by

Lysaght Bros. & Co. Ltd.

Head Office : 17-19 Bridge Street, Sydney
Works : Parramatta River

Agents for Victoria : Gibbs, Bright & Co., 34 Queen Street, Melbourne

WHERE ARE YOU GOING — *Financially?*

A CHILD on a rocking-horse is content with motion without progress. But a man who likes to feel that he is getting somewhere cannot afford to adopt the rocking-horse method in his financial affairs.

He wants to feel that he is moving forward—that each year finds him a little better off than last.

There is one way to make sure of that, particularly if your income is a fixed quantity—that is, by planned spending. So spend that you can *SAVE!*

Wise spending and consistent saving may mean slow progress, but it will at least be sure.

State Savings Bank of Victoria

213 Branches, 373 Agencies *ALEX. COOCH, General Manager*

DEPARTMENT OF AGRICULTURE, VICTORIA

A new Bulletin

PRICE 3D. *(Posted 5d.)*

TOBACCO GROWING IN VICTORIA

is now on sale!

This Bulletin, which is profusely illustrated, gives a detailed account of the processes involved in the production and marketing of high-grade tobacco from the seed-bed to the buyer.

IMPORTANT FEATURES INCLUDE —

Soil and Climatic Requirements	Transplanting	Harvesting
Varieties	Transporting Seedlings	Curing
Seed-bed Construction	Irrigation	Baling
Sowing the Seed	Topping and Suckering	Marketing
Care of Seedlings	Flue-curing Barns	Blue Mould

Obtainable from the Director, Department of Agriculture, Melb., C.2

5,858,377 TONS

5,858,377 Tons of Goods and Live-stock were carried by the Victorian Railways for the year ending 30th June, 1934, at an average charge of

Only Three Ha' pence per Ton-Mile

This is convincing evidence of the **incomparable service** which your railways are giving you.

For the Smallest Parcel to the Largest Consignment

THE RAILWAY — ALWAYS !

Save Money by using
Texaco Super Power Kerosene

From practical experience, thousands of farmers know that in successful farming, Texaco Super Power Kerosene plays a big part.

For here is a clean, pure fuel which vaporises instantly and burns completely—leaving a minimum of carbon. It gives more power, more acreage and reduces repair bills.

Try Texaco Super Power Kerosene to-day, and you, too, will pay a high tribute to this wonderful fuel.

TEXACO
SUPER POWER KEROSENE

THE VICTORIA HERD

of Red Poll Cattle

Maintained for Milk and Beef at the State Research Farm, Werribee.

R.M.C.

FOR SALE

6 BULL CALVES

No. 1. VICTORIA CONSTANTINE. (A., C.R.). Born 15th October, 1933.. *Price* 25 guineas
Sire : Dominion Bright Belgian (Imp. N.Z.) (1195 A). *Dam :* Victoria True Blue (3039 A). f.o.r. Werribee
Victoria True Blue has produced 391 lb. butter-fat in 365 days as Sr. 4.

No. 2. VICTORIA BOLD VELVET. (AA., C.R.). Born 3rd January, 1934.. *Price* 22 guineas
Sire : Victoria Gallant (1481 AA). *Dam :* Victoria Royal Velvet (3518 AA). f.o.r. Werribee
Victoria Royal Velvet produced 247 lb. butter-fat in 273 days as Jr. 2. (An AA calf.)

No. 3. VICTORIA GOLIATH. (B., C.R.). Born 2nd April, 1934 .. *Price* 26 guineas
Sire : Dominion Bright Belgian (1195 A). *Dam :* Victoria Cutty Sulu (1284 C). f.o.r. Werribee
Victoria Cutty Sulu produced 493 lb. butter-fat in 365 days as Sr. 4.

No. 4. VICTORIA TINKER. (A., C.R.). Born 13th July, 1934 .. *Price* 13 guineas
Sire : Dominion Bright Belgian (1195 A). *Dam :* Victoria Tinka Belle (2434 B). f.o.r. Werribee
Victoria Tinka Bell produced 265 lb. butter-fat in 333 days as Sr. 3. Won Third Prize, Melbourne Royal Show, 1929.

No. 5. VICTORIA VESUVIAN. (A., C.R.). Born 26th September, 1934.. *Price* 13 guineas
Sire : Victoria Gallant (1481 AA). *Dam :* Victoria Vesuvius (2344 A). f.o.r. Werribee
Victoria Vesuvius produced 271 lb. butter-fat in 333 days as Jr. 2. Won First Prize, Melbourne Royal Show, 1932

No. 6. VICTORIA FROLIC. (A., C.R.). Born 18th October, 1934 .. *Price* 10 guineas
Sire : Woodburn Peter Pan (Imp. in utero) (1504 AA). *Dam :* Victoria Gilpey (4048 B). f.o.r. Werribee
Victoria Gilpey is an untested heifer.

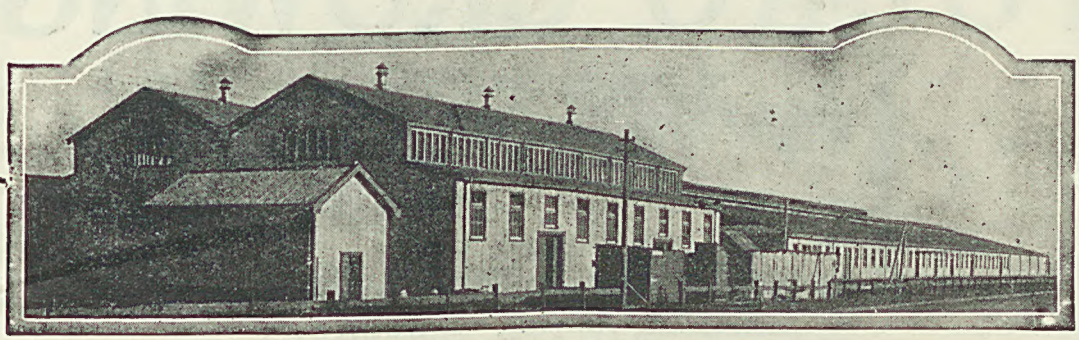
Prices are based on the butter-fat production of the dam at the rate of 1/- per lb., except in the case of progeny of heifers without completed test, the price then being 10 guineas.

An amount of 2 guineas per quarter maintenance has been added to calves 6 months old and over.

Inspection cordially invited. For further particulars apply to—

THE DIRECTOR OF AGRICULTURE, MELBOURNE, C.2; OR THE MANAGER, STATE RESEARCH FARM, WERRIBEE.

DEPARTMENT OF AGRICULTURE



GOVERNMENT COOL STORES

VICTORIA DOCK

THE STORES have a capacity of **1,361,072 cubic feet insulated,** and are capable of holding **680,000 boxes of butter,** or **450,000 cases of fruit,** or **600,000 carcasses of lamb and mutton.**

Electric motor power totals 1,000 h.p.

Produce can be placed on conveyors at any point and mechanically carried to any chamber in the building.

THE RAILWAY DEPARTMENT GOODS SHEDS are adjacent to and connected with the Cool Stores by direct lines ; delay and exposure of produce through shunting in the Spencer-street yards, or cartage, are thus avoided. The Stores are situated in close proximity to the Victoria Dock, where vessels drawing up to 30 feet of water can be berthed ; excellent facilities for the efficient and economical treatment and shipment of frozen and perishable products are provided.

EXPERT OFFICERS are connected with every Branch, so that any one requiring information regarding the production, preparation, and shipment of produce can rely upon being promptly supplied with up-to-date information upon all matters.

RATES for treatment and storage may be obtained on application to the Exports Superintendent, Department of Agriculture, Produce Offices, 605 Flinders Street, Melbourne, C.3.

POTATO GROWING
. . . in VICTORIA . . .

"POTATO GROWING in VICTORIA" is a new bulletin that has just been issued by the Dept. of Agriculture. Written by the Department's potato expert, Mr. J. T. Ramsay, the bulletin covers all phases of potato growing. It incorporates in an improved manner everything of interest that appeared in the old *Potato Bulletin,* in addition to much new material and the results of experiments carried out in various parts of the State during recent years.

Subjects dealt with include seed selection, storage, manuring, planting, irrigation, and harvesting, while one chapter is devoted to a description and methods of control of the principal diseases and pests.

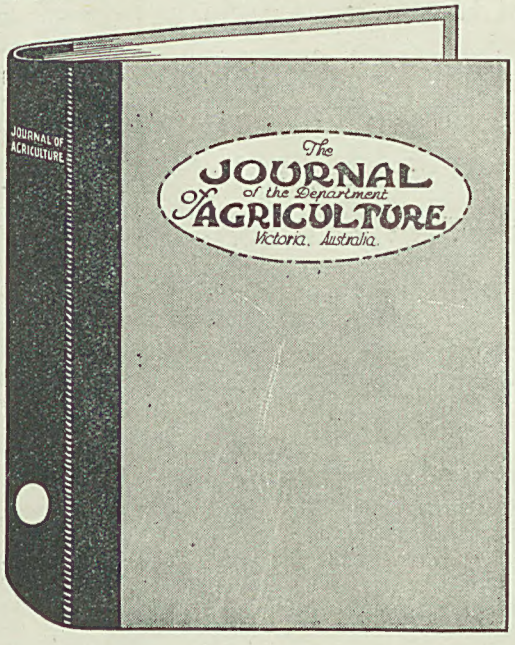
PRICE 5D. (including postage)

Obtainable from the Director of Agriculture, Melbourne, C.2

DEPARTMENT OF AGRICULTURE

Keep your Journals Together . . .

A HANDSOME gold-embossed Cover in which monthly copies of the Journal of Agriculture are easily bound may be obtained from the Department of Agriculture.



Made to hold 12 monthly copies and the annual index, this Cover will keep your Journals clean and in proper sequence and insure you easy and immediate access whenever reference is necessary.

Price 1s. 6d. Post Free

Obtainable from the Director, Department of Agriculture

The Journal of Agriculture

A VALUABLE Guide to improved farming practices and an essential aid to the solution of the many problems which confront the primary producer.

THE Journal of Agriculture contains interesting and informative articles written by expert officers of the Dept. of Agriculture and dealing with all phases of primary production.

The Journal records the results of the latest experimental and research work carried out on State and private farms and in the laboratory by the scientists of the Dept.

These articles constitute a valuable guide to improved farming practices and an essential aid to the solution of some of the many problems with which the producer is continually faced.

No agriculturist, grazier, dairy farmer, horticulturist, or poultryman can afford to disregard the help of the scientists and practical experts whose conclusions for practical application on the farm are recorded in the pages of this Journal.

Should you desire to have the Journal regularly each month, fill in the form below and forward it, together with cheque or postal note for 3s., to the Director of Agriculture, Melbourne.

The Director of Agriculture, Melbourne.

Please forward the Journal of Agriculture to me monthly as published, beginning with the issue for the month of .....

I enclose cheque / postal note *for three shillings to cover my subscription for one year.*

(Name).....

(Postal Address).....

.....

By Authority: H. J. GREEN, Government Printer, Melbourne.

SP 630.5 V645